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LATE MENOPAUSE AND CANCER OF THE BREAST

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Several observers have suggested that a positive relationship may exist between the occurrence of menopause at an advanced age and the development of cancer in the tissues of the female reproductive organs. Thus Crossen and Hobbs (1) state that "the incidence of late menopause in cases of adenocarcinoma of the fundus uteri is about four times as high as it is in normal cases," while Olch (2) finds a similar relationship between a delayed menopausal age and cancer of the breast. Among his cases of 342 women suffering from breast cancer, and first coming to medical attention after the age of fifty, Olch's records showed that 187, or 54.7 per cent, were either still menstruating or had stopped after fifty. In Olch's opinion this was about five times the proportion to be expected, accepting as "normal" the figures cited in literature on the age at menopause among women in temperate climates, which in various series appears to be fifty years or more in only nine to twelve per cent, or an average of eleven per cent of all the cases.

Many experiments with animals have established the fact of hormonal (estrogen) action in the production of mammary tumors and certain tumors of the body of the uterus. (3) (4) Thus it is quite conceivable that the prolonged hormonal stimulation incident to delayed menopause may be related to the development of malignancies in genital tissues. However, the question whether a delayed menopause actually coincides with an increased incidence of cancer of the breast and the corpus uteri is not only of theoretical interest in the study of tumor genesis, but is of great practical importance. For at least in connection with breast cancer it has already been recommended that "a prophylactic artificial menopause should be proposed to those women menstruating beyond any arbitrary age that we may choose, forty-eight or fifty, whether or not those women have palpable breast changes." (2)

The next question is whether the evidence for a direct relationship between late menopause and the development of malignancies in breast or uterus is statistically so conclusive that such a procedure is warranted. Crossen and Hobbs (1) have rightly warned against "certain pitfalls in gathering statistics on normal menopause which have not been taken into account in the compilation of statistics in the present day literature." One such pitfall lies in the use of antiquated data to arrive at a so-called "normal" menopausal age. For it is the impression of many experienced physicians and statisticians that during the last few decades the menstrual cycle has changed its range considerably in many countries, so that figures gathered fifty or seventy years ago cannot be accepted as a basis for judging conditions today.

But from still another viewpoint the conclusion drawn from Olch's material does not seem to be quite valid, at least as to specific estrogenic action on cancer of

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the breast, in the absence of comparative data on the incidence of cancer of other sites collected from a similar population. The writer has therefore attempted to secure further evidence on this problem by comparing the conditions found in a series of cases of breast cancer with those in a series of cases of cancer in tissues not usually assumed to be under ovarian influence, such as the skin, the lips, the tongue, and the gastrointestinal tract. The investigation was confined to mammary cancer because of the comparatively rare incidence of carcinoma of the body of the uterus. Further it appeared desirable to compare the distribution of menopausal age among cancer patients with that among women in a general hospital, suffering from various non-cancerous conditions, whether under surgical or general medical care.

The three series of cases were drawn from medical records in the Columbus Cancer Clinic, and the Ohio State University Hospital, and may be presumed to be largely homogeneous, from the environmental point of view. The author is deeply indebted to the officers of these two institutions for their courtesy and co-operation in this investigation as well as to Dr. Earl L. Green, of the Ohio State University, for his statistical advice.

METHOD AND PROCEDURE

In drawing the cases from the files of clinic and hospital, the common principle of selection was that the patient should have been admitted when at least fifty; that information was available as to the age at menopause (i. e., the final cessation of the menstrual flow); and that there was no history of previous pelvic operation. Otherwise these were random samples compiled from the records of 1921–1941.

TABLE I

AGE AT MENOPAUSE REPORTED BY THREE GROUPS OF PATIENTS WITH (I) CANCER OF BREAST, (II) CANCER OF NON-GENITAL TISSUES, AND (III) CONDITIONS OTHER THAN CANCER. (Columbus, Ohio, 1941.)

REPORTED AGE AT MENOPAUSE	SAMPLE I Breast Cancer		SAMPLE II Non-genital Cancer		SAMPLE III Other than Cancer	
	No.	%	No.	%	No.	%
Under 40	3	2.0	4	2.4	3	5.0
40–44	21	14.3	28	17.2	7	12.0
45–49	39	26.6	56	34.4	21	35.0
50 and over	84	57.1	75	46.0	29	48.0
Total	147	100.0	163	100.0	60	100.0

The two series from the Cancer Clinic included, in Sample I, 147 cases of cancer of the breast; and in Sample II, 163 cases of cancer of other sites, mainly "external" and all strictly non-genital and non-mammary. Sample II was made up of 128 cases of cancer of the skin, lip, and oral cavity, together with 35 cases of cancer of the gastrointestinal tract and accessory bodies such as the gall-bladder.

The age at menopause for the two groups of women is shown in Table I. From this it will be seen that the proportion of women reaching the menopause when younger than forty is about the same for the two groups, although it is a fraction larger in the group with non-genital cancer; while the proportion reaching the menopause between forty and forty-four is three points higher in the non-genital group; and between forty-five and forty-nine the non-genital group is eight points higher.

But the group with breast cancer reported menopause at fifty or over in 57 per cent of the cases, as compared with 46 per cent among the non-genital cancer group.

The figure of 57 per cent in our series of cases with breast cancer compared well with the 55 per cent cited by Olch in his series of 342 cases; and the apparently high coincidence of late menopause with cancer of the breast seemed to confirm his conclusion of a causative relationship. But later critical examination makes it appear that these figures can be accepted as establishing prolonged estrogenic action as a causative agent in the development of mammary cancer *only* if the distribution of menopausal age can be shown to be strikingly different among cases of cancer of tissues which are not usually assumed to be influenced by estrogenic action. However, as shown in Table I, among the 163 women suffering from cancer of the skin, lip, oral cavity or gastrointestinal tract, 75, or 46 per cent, likewise reached the menopause after fifty. If the 35 cases of gastrointestinal cancer are excluded, the others with purely "external" cancer show 47 per cent menstruating after fifty. But this is a figure at least four times as high as would be expected if we assume with Olch that only about eleven per cent of women are normally in this group.

Two explanations for this surprising fact suggest themselves: First, if the figure of eleven per cent—or about one in nine—is considered as a normal incidence of late menopause, the inference is that cancer of other tissues beside the genital are likewise related to a prolongation of estrogenic activity. Such a possibility cannot be disregarded in the light of discoveries in animal experimentation. Leo Loeb (3) has pointed out that in animals, carcinogenic action of the estrogens is not necessarily *specific* for the development of mammary cancer; and he and other observers have found sarcoma developed after prolonged estrogenic treatment, sometimes in regions remote from the site of the injections. Lacassagne (7, 8) e. g., has found sarcomas in the bladder and in the thymus after prolonged estrogen treatment. (See references for the more important of these findings by Leo Loeb (3); C. F. Cori (5); W. U. Gardner, G. M. Smith, L. C. Strong and E. Allen (6); A. Lacassagne (7) (8); and E. L. Burns, V. Suntzeff, and L. Loeb (9).)

It is possible therefore that prolonged estrogenic action might have been effective in the production of a high incidence of cancer of various non-genital tissues in our series of women.

However, another explanation is possible, and that is that the percentage of women who "normally" reach the menopause when fifty or older, is greater than might be assumed from figures cited in the earlier literature, so that the women with cancer of various tissues who also reach the menopause at an advanced age simply represent the common condition. If there is on the contrary a positive correlation between late menopausal age and cancer of the breast and other tissues, one is bound to find statistically significant differences in the distribution of this age among cancerous and non-cancerous cases in the same population at the same period.

To follow this lead, a third series of cases was gathered, this time from the Ohio State University Hospital, and makes up Sample III, a group of women suffering from various surgical and general conditions, all definitely non-cancerous, such as fractures, gastric ulcers, cholecystitis, arthritis, and metabolic disturbances. All cases with previous pelvic operations were excluded; and all in which there was evidence of some pelvic or endocrine condition which might have influenced the onset of menopause; and of course cases with a history indicating possible malignancy at any time were ruled out. Since the age at menopause is not recorded routinely in a general hospital, the range of choice was further limited. Finally after the examination of many hundreds of records, sixty cases were found which met all the specifications. To possible criticisms of the small size of this sample the answer is offered that a relatively few cases gathered as nearly as can be

under identical conditions offers a better basis for statistical comparison than a large number collected from a wide variety of sources in the literature of different countries and times, and representing completely disparate environmental conditions.

Subdivided according to the age at menopause, Sample III also appears in Table I. Comparing this distribution with that in Sample II, the non-genital cancer cases, one is struck by their close similarity in the groups reaching menopause at forty-five or forty-nine and after fifty.

By comparing the three samples it is clear that the breast cancer cases do not differ markedly from the other groups, although there is a lower incidence of menopause at ages younger than fifty and a considerably higher incidence of menopause at fifty or more. But, as the table clearly shows, these differences in the incidence of a late menopause in the cases of breast cancer and in the series of non-genital cancer and non-cancerous cases are not great enough to warrant conclusions as to a causative relationship between delayed menopausal age and cancer of the breast.

When a statistical comparison is made of the two percentages of women with menopause after 50, with and without breast cancer, it is found that the difference (11.1 = 57.1—46.0) is almost exactly 1.96 times its own standard error, and therefore has a 5 in 100 chance of being due to sampling fluctuation alone. Statistically therefore it cannot be interpreted either definitely in the positive or definitely in the negative. In any case, the conclusions which can be drawn from the figures given do not sufficiently support the above mentioned statements as to a true association between a late menopausal age and cancer of the breast.

For this reason it would appear that the proposal to induce an artificial menopause in cases with a delayed menopause in order to prevent mammary cancer has not as yet on a secure statistical basis.

GENERAL DISCUSSION

From a practical point of view the conclusions which may be drawn from our data are unsatisfactory, since they demonstrate only the fact that we are far from an answer to the question of the relation between late menopausal age and cancer of the breast. The author's findings in this investigation are in complete agreement with those arrived at by E. K. Dawson (10) who in his paper, "The Menopausal Age and Mammary Cancer" was able to say only that "the figures representing the age distribution of the menopause and the incidence of cancer of the breast are not *inconsistent* with the hypothesis, suggested by other considerations, that a correlation exists."

In fact, one may admit that the hypothesis of such a correlation suggests itself also from the author's present data, with the high coincidence of breast cancer and late menopausal age, 57 per cent as compared with 46 or 48 per cent in the non-genital cancerous and the non-cancerous groups, even if the difference reaches only the borderline of statistical significance. But much more work must be done before one can arrive at a safe basis for judgment.

One of the main hindrances to the solution of the problem is ignorance of the actual facts with regard to the normal age distribution at menopause. Existing statistics are for the most part antiquated, as for example the frequently cited figures of Kisch which were published in 1874 (11), those of Currier (12) (1897) and of Krieger (13) (1869); or when later figures are used, they may be drawn from scattered or inadequate sources; and insufficient account is taken of the completely different environmental conditions existing among the women in the various groups which may be under consideration, so that the figures may not be truly comparable for statistical purposes.

Other pitfalls are inherent in the method of collection and evaluation of the desired data. For example, the writer collected his age data by single years, but for this particular investigation presented them in the same classification as Olch, by five-year groups—40–44, 45–49, 50 and over—so that the results might be compared. This arrangement however is not satisfactory for statistical purposes, because of the peaks naturally occurring at the years forty, forty-five and fifty. For women are inclined to give the age at menopause in round figures, especially if several years have passed. The characteristic peak at the fiftieth year is shown very clearly in Dawson's tables (11). In his series of 244 "normal" surgical cases, the figures go as follows:

46 cases at 47 years
24 " " 48 "
24 " " 48 "
23 " " 49 "

then jump to

52 cases at 50 years

and fall again to

10 cases at 51 years
10 " " 52 "
8 " " 53 " and so on.

The author has found the same inexact memory about the age at menopause in many cases under observation; these artificial peaks at the five year or ten year intervals are familiar to all students of population statistics, making a major source of error in interpretation. But this fact is bound to have an especially important bearing on our problem, since it is precisely the year fifty which is considered the point marking a delayed or non-delayed menopause. Therefore, it is evident that the conclusions to be drawn from such investigations may depend more or less upon the way in which the year "fifty" is dealt with, i. e., whether the age groups are subdivided, e. g., in those from 40 to 44, 45 to 49, 50 and over; or whether the same material is subdivided into the groups 41 to 45, 46 to 50, 51 and over, as some authors prefer. Only the most carefully collected material, by single years, checked and verified wherever possible by clinical inquiry, can serve our need for exact data with regard to the relation between delayed menopause and cancer.

Aside from purely statistical considerations it seems highly desirable to elucidate the whole biological question of the possible role of prolonged estrogenic activity in the development of cancer in the female genital tissues. This requires the consideration of the length of the entire menstrual cycle, so that the age at onset of menstruation should be registered as well as the age at its cessation.

It is a striking and apparently well-established fact that, at least in our temperate climate, menopause at a late age usually occurs in women who started to menstruate at an early age; the reverse condition also being true, that the later the onset the earlier the cessation, as described by E. Novak (14) (15). Individual women will therefore differ considerably in their experience of estrogenic activity, and it may be assumed that these differences in the length of the menstrual cycle have an important bearing on our problem. Thus a woman starting to menstruate at the age of twelve and stopping at fifty-four, with a consequent cycle of forty-two years, may naturally show a quite different biological reaction of the tissues to estrogenic activity from that of the woman starting at sixteen and ending at forty-eight or earlier, with a cycle of estrogenic activity of thirty-two years or less.

Hereditary factors enter into the question of the differences in the range of the menstrual cycle, a phase which has been of interest to the writer for a number of years. E. Petri (16), by means of careful investigation into the records of identical and non-identical twins and of sisters in large families, has already accumulated

much evidence for the determination by genetical factors of at least the onset of the cycle. It is still an open question as to how much hereditary factors, in inter-action with environmental factors, are operative in the varying ranges of the menstrual cycle.

A far more extensive body of material is needed on the actual experience of women with regard to the menstrual cycle than has yet been available and an investigation is now under way which may lead to some understanding of the fact that "breast cancer runs in certain families."

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Gustatory Experimentation

It is a case of circumstance where professors who appreciate the amenities also learn to face somewhat rigorous temporary conditions at field stations. Two such, Professor Fernald of Harvard and Professor Kinsey of Indiana University, have met the tests at both extremes and put their talents together to produce a book on edible wild plants that is a gem of its type. Since it is in part a botanical manual and in part a cook book with recipes, the merit of the book lines in its quality rather than in its novelty. The statement that a lack of knowledge of calories at the time the manuscript was begun caught this reviewer's eye, and a letter to Professor Kinsey brought the prompt and courteous reply that the work was begun twenty-five years ago. "Both Professor Fernald and I," the letter goes on to say, "have done a great deal of camping and had learned independently something of the use of our wild plants." And it should be added that the experiences of a quarter of a century of camping and trying out new foods make even seed catalogs tame in comparison. The reader is shown identifying traits of poisonous plants. There are line drawings, references to a wide range of literature and a general atmosphere of enthusiasm that makes good reading.—*A. E. Waller.*

Edible Wild Plants of Eastern North America, by Merritt Lyndon Fernald and Alfred C. Kinsey. 452 pp., line drawings, photographs, bibliography, index. Idlewild Press, Cornwell-on-Hudson, N. Y., 1943. $3.00.

NOTES ON MEXICAN AND CENTRAL AMERICAN PSYLLIDAE (HOMOPTERA)

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All species in this report, unless noted otherwise, were taken by Dr. D. M. DeLong, Dr. C. C. Plummer, Mr. Gene Good, and the writer the fall of 1941. Deposition of type material is in the writer's collection.

Livia mexicana n. sp.

(Fig. 1)

Length to tip of forewing 3.1 mm., forewing 2.3 mm.

General color orange-brown over all, entire venter and tips of antennae black.

Vertex one and a half times as long as broad, not deeply notched cephalad; eyes flattened. Forewings twice as long as broad, ovate, rugose, translucent. Forceps of male almost as long as proctiger, caudal margins evenly lunate, apices diagonally truncate, cephalic margins suddenly expanded basally at midlength.

This species somewhat resembles *vernalis* Fitch but is smaller with a more shallow notched vertex and distinct genitalia.

Male holotype near Orizaba, near Vera Cruz, October 17, 1941, from sedge and grass in an oak-pine association.

Aphalara simila Cald.

Two specimens from Uruapan, Michoacan, October 1, 1941, from roadside weeds.

Heteropsylla texana Crawford

A few specimens from Tehuacan, Puebla, October 17, 1941, and very common at Tehuantepec, Oaxaca, October 13, 1941, on "Huasache."

Heteropsylla mexicana Crawford

Specimens taken from semi-desert vegetation between Jacala and Zimapan, Hidalgo, and near Zamora, Michoacan.

Heteropsylla forcipata Crawford

(Figs. 2 and 2A)

One male specimen recognized from Tehuantepec, Oaxaca, October 13, 1941, taken along with many specimens of *mexicana* Crawf. The genitalia of this specimen is not exactly as Crawford[1] has illustrated, but it is structurally the same, the difference in appearance probably being due to treatment with caustic.

Heteropsylla huasachae Cald.

This species was very abundant at Tehuantepec, Oaxaca, on "Huasache." Dr. Plummer also took this species at Popaya, in Guatemala, March 9, 1942.

Heteropsylla didubiata n. sp.

(Fig. 3)

Length to tip of forewing 2.6 mm., forewing 2.2 mm.

General color light yellow green over all.

Head as broad as thorax; genae greatly swollen; clypeus very prominent. Thorax strongly

[1]1914. Crawford, D. L. U. S. N. M. Bull. 85, pl. 8, figs. 116–118.

arched, robust. Forewings almost two and a half times as long as broad; pterostigma very broad and long. Female genital segment as long as rest of abdomen; dorsal valve abruptly styliform in apical half; ventral valve almost as long as dorsal, acute apically.

Female holotype and paratype from Tamazunchale, San Luis Potosi, November 15, 1938 (Caldwell).[2]

This may be the female of *forcipata* Crawford but the writer believes not because this species is much larger than the specimens of *mexicana* or *forcipata* and the color is definitely green and not brown or black as in those species; furthermore this species was taken while sweeping lush tropical vegetation while the former mentioned species were found on plants in a semi-desert habitat.

Carsidara dugesii Loew

One female from Carapan, Michoacan, October 2, 1941, Km. 432, and numerous specimens of both sexes from Popaya in Guatemala, Km. 99, March 9, 1942, by Dr. Plummer.

Rhinopsylla nigra Laing

(Fig. 17)

1923. *Rhinopsylla nigra* Laing, Ann. & Mag. Nat. Hist. (9) 11: 697.

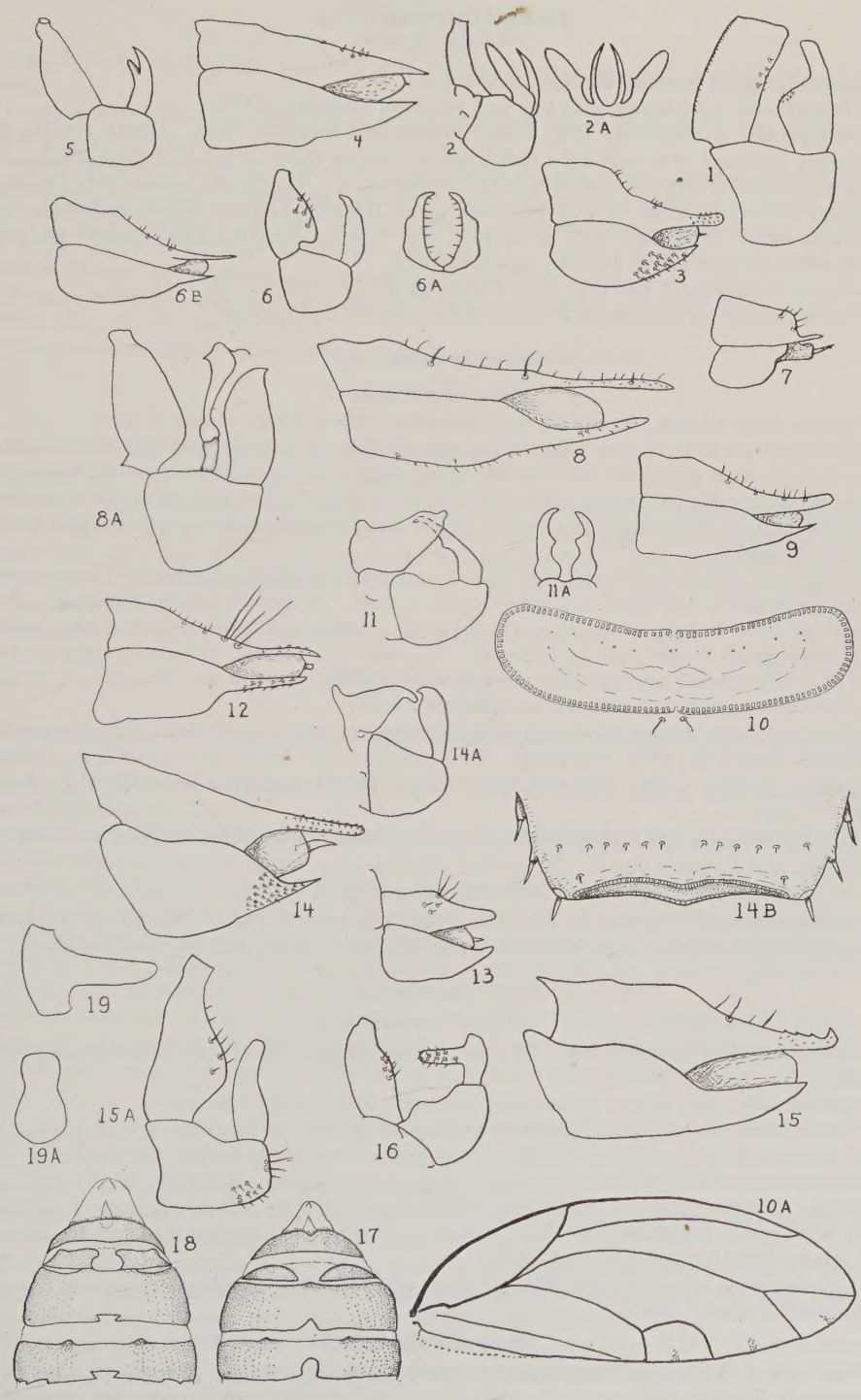
This collection contains thirty specimens from Tuxpan, Carapan, Uraupan, and Zitacurao, Michiocan, Orizaba, Veracruz, and Puebla, Puebla. The female exhibits the sexual dimorphism typical of the Rhinopsylla. Though the ground color is black, the vertex, pronotum, and praescutum are pink to light tan and the scutum has four light stripes. The female is a good deal larger than the male, measuring 3.4 mm. to tip of forewing, with a forewing of 2.9 mm. The ventral valve of the genital segment is scarcely shaped, appearing just like a last ventral segment.

Holotype female from Orizaba, Veracruz, October 5, 1941, paratypes from the above mentioned localities. This species is closely related to *rubrafacia* Caldwell. (Fig. 18.)

[2]1941. Caldwell, J. S., Ohio Jr. Sci. 41: 420. (Under *H. forcipata.*)

EXPLANATION OF PLATE I

1. *Livia mexicana.* Profile of male genitalia.
2. *Heteropsylla forcipata* Crawf. Profile of male genitalia.
2. A. Caudal view of male forceps.
3. *Heteropsylla didubiata.* Profile of female genitalia.
4. *Paratrioza plummeri.* Profile of female genitalia.
5. *Trioza rugosata.* Profile of male genitalia.
6. *Trioza stroma.* Profile of male genitalia.
6 A. Caudal view of male forceps.
6 B. Profile of female genitalia.
7. *Trioza zogoda.* Profile of female genitalia.
8. *Trioza apartata.* Profile of female genitalia.
8 A. Profile of male genitalia.
9. *Trioza hidalgoensis.* Profile of female genitalia.
10. *Trioza epiphitata.* Circum-anal ring of immature.
10 A. Forewing of adult.
11. *Trioza albanigra.* Profile of male genitalia.
11 A. Caudal view of male forceps.
12. *Trioza rugosata.* Profile of female genitalia.
13. *Arytaina virgina.* Profile of female genitalia.
14. *Mitrapsylla deserata.* Profile of female genitalia.
14 A. Profile of male genitalia.
14 B. Abdominal apex of immature.
15. *Caradocia delongi.* Profile of female genitalia.
15 A. Profile of male genitalia.
16. *Psylla minutiforma.* Profile of male genitalia.
17. *Rhinopsylla nigra* Laing. Sclerite formation on ventral side of female abdomen.
18. *Rhinopsylla rubrafacia* Cald. Sclerite formation on ventral side of female abdomen.
19. *Paratrioza simila.* Profile of male proctiger.
19 A. Circum-anal ring of female.


5
4
2
2A
1
6B
6
6A
3
7
8
8A
9
11A
11
12
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14A
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14B
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19A
15A
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15
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10A

Paratrioza plummeri n. sp.

(Fig. 4)

Length to tip of forewing 3.5 mm., forewing 3.1 mm.

General color light brown with legs and venter of abdomen yellow.

Vertex twice as broad as long, foveal impressions elongate, deep. Genae swollen subspherically; antennae over one and a half times as long as width of head; clypeus small. Pronotum small, greatly depressed; praescutum as broad as long. Vertex and thorax finely pubescent. Forewings over three times as long as broad, acute apically; humeral angles darkened; radial sector very long. Hind tibiae with apical spur ratio of 2–1. Female genital segment as long as rest of abdomen, both valves gradually acute apically.

Female holotype and paratype from Tehuacan, Puebla, October 17, 1941.

The writer names this species in honor of Dr. Charles C. Plummer.

Paratrioza simila n. sp.

(Figs. 19 and 19A)

Length, male 3.4 mm., female 3.8 mm.; forewing, male 2.8 mm., female 3. mm.

Color and markings of male identical to *cockerelli* Sulc except concentric macula in center of vertex is much more prominent and the thorax is possibly less black with more red background. Female predominently red-orange with a black spot in either half of the vertex and a few black dashes laterally on either side of the notum. Both sexes have the abdomen black above and the forewings yellowish.

Vertex not especially emarginate. Genal cones short, blunt, divergent. Clypeus large. Antennae one and a half times as long as width of head. Pronotum greatly depressed. Forewings three times as long as broad, acute apically. Proctiger of male with very long, slender, lateral flaps, much longer than in *cockerelli*. Forceps long, slender, siculate apically. Dorsal valve of female genital segment short, blunt; anal opening shape of an "hourglass." Ventral valve one-third as long as dorsal, not acute apically.

Male holotype, female allotype, and paratypes of both sexes from San Cristabol in Guatemala, March 30, 1943 (Plummer). Two male and two female paratypes from Carapan, Michoacan, October 4, 1941, and two male and one female paratypes from Rio Frio, Puebla, October 7, 1941.

Where this species and *cockerelli* Sulc. occur together *simila* may be easily recognized by its larger size.

Paratrioza cockerelli Sulc.

Taken as far south as Km. 55, Rio Frio, Puebla, October 7, 1941. The Rio Frio specimen was taken from fir and pine at an elevation of about 10,000 ft. along with specimens of *simila*.

Trioza rugosata n. sp.

(Figs. 5 and 12)

Length to tip of forewing, male 2.9 mm., female 3.4 mm.; forewing, male 2.5 mm., female 2.6 mm.

General color dark brown; genal cones, antennae, and legs light brown.

Vertex about one and a half times as broad as long, swollen on either side of median line. Genal cones as long as vertex, slender, acute. Antennae scarcely longer than width of head. Vertex and thorax finely and evenly pitted. Forewings over twice as long as broad, not acute. Metacoxae with caudal spurs. Hind tibiae with apical spur ratio of 3–1. Forceps of male with deeply bifed apices projecting cephalad. Female genital segment shorter than rest of abdomen; both valves abruptly stylate in caudal half.

Male holotype from Zimapan, Hidalgo, September 26, 1941; female allotype from Carapan, Michoacan, October 2, 1941.

Trioza thoracia Cald.

One male of this unique humpbacked species from Puebla, Puebla, October 18, 1941, on an unidentified roadside weed.

Trioza stroma n. sp.

(Figs. 6 and 6A)

Length to tip of forewing, male 2.8 mm., female 3. mm.; forewing, male 2.4 mm., female 2.5 mm.

General color yellow with apical half of antennae and dorsum of thorax black; apical angles of forewings yellowish.

Vertex only one-fourth broader than long. Genal cones as long as vertex, slender, acute. Antennae one and a half times as long as width of head. Head about as broad as thorax. Thorax short. Forewings almost three times as long as broad, rather broadly rounded; cubital and medial cells small. Hind tibiae with apical spur ratio of 3–1. Forceps of male short, stout, acute apically. Dorsal valve of female with extremely fine styliform apex for apical fourth.

Female holotype, male allotype, five male and five female paratypes from Cuernavaca, Morelos, Km. 57, October 21, 1941.

This species resembles *chlora* Tuthill and *nicaraguensis* Crawford.

Trioza zogoda n. sp.

(Fig. 7)

Length to tip of forewing 3. mm.; forewing 2.5 mm.

General color brown with head and legs yellow.

Vertex almost as long as broad, almost vertical. Genal cones three-fourths as long as vertex, acute, divergent. Head almost as broad as thorax. Thorax rather flat; prothoracic dorsum suddenly depressed, vertical. Forewings rather broadly rounded. Hind tibiae with apical spur ratio of 3–1. Female genital segment with both valves appearing short, chubby; dorsal valve with needle-like apex.

Female holotype from Orizaba-Puebla road, Km. 277, October 17, 1941.

Trioza apartata n. sp.

(Figs. 8 and 8A)

Length to tip of forewing, male 4.2 mm., female 5. mm.; forewing, male 3.5 mm., female 4.1 mm.

General color brown; antennal joints, apical tarsi, abdomen, genital segment, and basal angles of forewings blackish.

Vertex one and a fourth times as broad as long; foveal impressions very deep, broad, making lateral and basal margins of vertex appear raised and ridged. Genal cones as long as vertex, appressed for full length. Antennae twice as long as width of head. Pronotum depressed almost vertical; mesoscutum as long as broad, rather acute cephalad. Forewings almost three times as long as broad, broadly rounded apically. Metacoxae with caudal spurs. Hind tibiae with apical spur ratio of 3–1. Female genital segment as long as rest of abdomen, narrow, styliform for full length. Forceps of male stout, bearing short chubby spurs at apex.

Female holotype and seven paratypes from Zimapan, Hidalgo, September 26, 1941; one paratype from Jacala, Hidalgo, September 26, 1941, and one from Orizaba, Veracruz October 17, 1941; male allotype and four paratypes from Jacala, and one from Zimapan, Hidalgo, September 26, 1941.

Trioza hidalgoensis n. sp.

(Fig. 9)

Length to tip of forewing 3.5 mm.; forewing 2.8 mm.

General color black with entire praescutum and a broad stripe on scutum red; margins and center of vertex orange, making a black U on the vertex.

Vertex twice as broad as long. Eyes prominent. Genal cones three-fourths as long as vertex, acute. Antennae one and a fourth times as long as width of head. Head as broad as thorax. Forewings little over twice as long as broad, rounded apically.

Metacoxae with caudal spurs. Hind tibiae with apical spur ratio of 3–1. Female genital segment not quite as long as rest of abdomen; dorsal valve styliform, elevated in apical third.

Holotype and paratype female from Zimapan, Hidalgo, September 26, 1941, on Moctezuma pine. This species is related to the *frontalis* Crawford group.

Trioza epiphitatae n. sp.

(Fig. 10)

Length to tip of forewing 2.4 mm., forewing 2. mm.

General color green-yellow over all.

Vertex almost twice as broad as long; foveae deep, broad. Genal cones as long as vertex, divergent. Antennae one and a half times as long as width of head. Forewings two and a half times as long as broad, acute apically; membrane somewhat rugose; cubitus separating from main stem a little before radius and medius. Metacoxae with very small caudal spurs. Hind tibiae with apical spur ratio of 3–1. Male forceps short, stout, ending apically in prominent spines.

Male holotype near Morelia, Michoacan, October 4, 1941, on an epiphite. This plant seemed to be scattered from the mountains just south of Monterrey, N. L., to Tamazunchale, S. L. P., and west of Mexico City from Morelia, Mich., to the state of Jalisco.

Whereas the forewing of this species is strictly neither Triozinae nor Cerophyllinae, the sectasetae on the immature are elongate like those on the Triozinae, therefore this species is placed in *Trioza*.

Trioza arizonae Aulmann

Specimens were taken from Orizaba, Veracruz, and Zamora, Michiocan, on different species of willow. Dr. Tuthill has suggested to the writer that this species may be nothing more than a color variety of *minuta* Crawford. The immatures of this species and those of the dark form of *minuta* seem to differ only in size and segmentation of the antennae. One specimen collected by Dr. Plummer at San Miguel in El Salvador, March 19, 1942, has a very narrow and elongate cubital cell in the forewing and may not be specific with the Mexican forms.

Trioza mexicana Crawford

Numerous specimens were taken at Mt. "El Popocataptl," September 28, 1941, at 11,500 ft. elevation. This species seems to be confined to the higher altitudes.

Trioza albanigra n. sp.

(Fig. 11)

Length to tip of forewing 3.1 mm., forewing 2.7 mm.

General color shining black except extremities of legs and segments III-IV-V of antennae white.

Vertex with broad shallow foveae. Genal cones half as long as vertex, acute, divergent. Antennae less than twice as long as width of head. Praescutum acute cephalad. Forewings almost two and a half times as long as broad, acute apically, yellowish. Hind tibiae with apical spur ratio of 2–1. Forceps of male strongly curved cephalad, acute apically, with a blunt spur located at midlength on inner margin.

Holotype male from Mt. "El Popocataptl," September 28, 1941, 10,800 ft. Paratype from Rio Frio, Puebla, October 22, 1941, 10,000 ft.

Trioza albanigra var. **aurodorsa** n. var.

Structurally similar to *albanigra albanigra*. Gold to orange over all except for black eyes and two black lines on scutum. Females with dorsal valve almost as broad as long; anal opening shape of "hourglass." Ventral valve broader than long in ventral aspect, not acute apically.

Male holotype, female allotype, and two paratypes from Rio Frio, Puebla, October 22, 1941, 10,000 ft.

Trioza koebelei Kirkaldy

Galls formed by the immature stages of this species were seen at Uruapan, Michoacan, and Cordoba, Veracruz. This species has been recorded from the State of Morelos by G. R. Valencia,[3] the State of Queretaro by D. S. Ibarra,[4] and the State of Tamaulipas by N. Stahler.[5]

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[3]1912. Valencia, Gabriel Ruiz. "Cultivo y Explotacion del Aguacate." Boletin numero 71 de la Estacion Agricola Central., pp. 50–51, (three plates).

[4]1929. Ibarre, David S. "El Aguacate" Secretaria de Agr. y Formento.

[5]1941. Stahler, N. Calif. Dept. Agr. Bull. No. 2, 39: 217.

Pachypsylla tropicala n. sp.

Length to tip of forewing 3. mm., forewing 2.6 mm.

General color black, vertex brownish. Forewing very clear, glass-like; a broken subapical black band present; apex brokenly maculate; pterostigma a black spot; black spot present on sutural margin half distance to claval apex; and a slightly darkened area present across cubital petiole.

Vertex twice as broad as long, roughened. Genal cones very short, twice as broad as long. Thorax not especially arched; covered with dense, short, white pubescence. Forewings over two and a half times as long as broad, ovate; pterostigma short, small. Forceps of male narrow, short.

Male holotype from Tepotzlan, Morelos, (collector and date unknown).

Arytaina virgina n. sp.

(Fig. 13)

Length to tip of forewing 2.4 mm., forewing 1.9 mm.

General color orange over all with indications of white stripes on thoracic dorsum, white spots around ocelli, and genal cones white with black tips.

Vertex twice as broad as long, very deep foveae on either side of median line. Genal cones very short, rounded. Head almost vertical with thorax strongly descending. Forewings two and a half times as long as broad; pterostigma very broad, long; cubital cell twice as large as medial. Female genital segment little over half as long as rest of abdomen; dorsal valve slender with apical third styliform; ventral valve thick, heavy.

Female holotype and two paratypes, Puebla, Puebla, October 18, 1941.

Mitrapsylla albalineata Crawford

This species was taken at Tehuacan, Puebla, October 17, 1941, on a shrub belonging to the Fabaceae. The specimens fit the variation that Crawford described from Oaxaca except that the female genitalia is not deflexed.

Mitrapsylla deserata n. sp.

(Figs. 14, 14A, and 14B.)

Length to tip of forewing, male, 2.2 mm., female 2.9 mm.; forewing, male 1.8 mm., female, 2.3 mm.

General color deep orange with a prominent median line for full length of thoracic dorsum white to yellow. Raised ridges on vertex light. Eyes, apices of antennae, and four marginal spots on forewings black.

Vertex almost twice as broad as long, central ridges very prominent. Genal cones very short, blunt. Antennae as long as entire insect. Head almost as broad as thorax. Forewings twice as long as broad; pterostigma very short; Cu_2 highly arched. Forceps of male with apical hooks projecting cephalad. Proctiger with long caudal flaps. Female genital segment as long as rest of abdomen; dorsal valve straight, flat dorsad; ventral valve acute, styliform in apical third.

Male holotype, female allotype, and many male and female paratypes from Tehuantepec, Oaxaca, October 13, 1941; one male paratype from Jesus Carranza, Veracruz, October 14, 1941; and two female paratypes from Iguala, Guerrero, October 25, 1941.

The immatures resemble those of psylla, especially the group with the anal opening located on the apex of the abdomen. The circum-anal ring appears to be a single ring of slit-like pores. The host plant is "Hausache."

Caradocia delongi n. sp.

(Figs. 15 and 15A.)

Length to tip of forewing, male 4.2 mm., female 5. mm.; forewing, male, 3.7 mm., female 4. mm.

General color bright blue-green with large golden spots on center of mesoscutum and laterally on metascutum; antennae beyond third segment black.

Vertex over twice as broad as long, pubescent, somewhat rolled roundedly forward. Caudal ocelli raised. Eyes stalked; postocular area large. Genae fused into vertex, separated basally

and contiguous apically; apices slender, acute. Antennae longer than entire insect. Thorax robust, arched. Forewings over twice longer than broad; costal margin greatly curved; medial and cubital cells very elongate. Forceps of male of even width throughout, curved cephalad. Proctiger with caudal flaps. Female genital segment as long as rest of abdomen; dorsal valve styliform in apical third, minutely serrate dorsad; ventral valve of equal length as dorsal, of heavy build throughout.

Male holotype and female allotype from Fortin, Veracruz, October 9, 1941.

This species may be separated from *godmani* Laing by the more prominent eyes, more slender genal cones, deeper cells in the forewings, and differently proportioned genitalia.

The writer takes great pleasure in naming this species in honor of Dr. Dwight M. DeLong.

Psylla minutiforma n. sp.

(Fig. 16.)

Length to tip of forewing, male 2. mm., female 2.3 mm.; forewing, male 1.6 mm., female 1.9 mm.

General color golden yellow over all with antennae black or dark apically.

Vertex almost twice as broad as long. Genal cones a third as long as vertex, thick, obtuse. Antennae scarcely longer than width of head. Forewings little over twice longer than broad; pterostigma very long, broad. Forceps of male invert L-shaped with apical arm a third longer than basal stem; there is a slight projection of the basal stem beyond the apical arm. Dorsal valve of female short, greatly narrowed apically.

Male holotype and female allotype from Tuxpan, Michoacan, Km. 168, October 5, 1941, and a male and female paratype from Zamora, Michoacan, Km. 458, October 2, 1941.

Psylla americana Crawford

Two species from Rio Frio, Puebla, October 7, 1941, on pine.

Psylla minuticona Crawford

Specimens from Chilpancingo, Iguala, and Mexacala, Guerrero, and from San Miguel in El Salvador, March 19, 1941, (Plummer).

A Modern Forestry Report

The most attractive paper bound book on the subject of forest resources that has been published in Ohio to date is the joint effort of the Agricultural Experiment Station and the Central States Forest Experiment Station staffs. Its colored cover is a reproduction of a photograph of a rolling farm landscape with some high grade timber logs ready for market. The back cover reprints a valuable essay by Louis Bromfield on the subject of conservation. Between these covers are maps, charts, photographs and significant discussion of our forest resources and problems. One fact out of many that is worth the reader's consideration is that while at present Ohio produces only 27% of all wood and 15% of timber consumed in the state, under forest management our people can bring that, over a period of years, to the point where consumption does not exceed annual growth increment. Just how this is to be accomplished is briefly suggested in the pamphlet. The reader is urged to concern himself in finding the answers.

Since such a publication issued for public distribution must be limited, it is hoped that it will reach those persons who will give it publicity or will reflect upon its findings. In attempting to cover the whole subject of forest planning and use, it is perhaps unavoidable that occasionally uneven treatment has resulted. Two staffs of specialists have engaged in the task. Yet on the whole there is a fine job of editing and co-operation, and it is to be hoped that more works of this type will be presented. The foreword by Mr. Secrest offers a unique reminder that during his career there has been a great change in viewpoint toward forestry. When he was himself almost the lone forester in the State of Ohio, the farmer and the forester were likely to be regarding each other antagonistically. It is significant of the modern perspective that we find a career forester the Director of an agricultural experiment station. As a progress report this paper is recommended to every reader of "The Ohio Journal of Science."—*A. E. Waller.*

Ohio's Forest Resources, edited by Oliver D. Diller. 109 pp., plus maps, charts, photographs. The Ohio Agricultural Experiment Station, Wooster, Ohio, in co-operation with The Central States Forest Experiment Station, Columbus, Ohio, 1944. No price indicated.

A NEW FISH SPINE FROM THE PENNSYLVANIAN OF OHIO

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The species described below increases to two the number of species of the ichthyodorulite genus *Ctenacanthus* recorded from the Pennsylvanian rocks of Ohio, the other species being *C. marshi* Newberry, 1873.

Genus **Ctenacanthus** Agassiz, 1837

Ctenacanthus lamborni Wells, n. sp.

(Plate I, Figures 1–6.)

Description.—Based upon an imperfect spine, measuring 9.2 cm. in length, anteroposterior diameter 11 mm. at the outer end, 26 mm. at the inner end. Transverse diameter 11 mm. Inserted portion and distal end not retained. Radius of curvature of anterior edge, 17 cm. Pulp cavity at outer end nearly cylindrical, 1 mm. in diameter; at inner end compressed, 5 mm. by 12 mm., with posterior surface virtually flat. Anterior edge with a single continuous smooth rounded costa, 2 mm. across, 1.5 mm. high, the sides of which bear obsolescent tubercles. Posterior face nearly flat with closely spaced linear strips separated by rows of fine pores, its lateral margins rounded, 1.5 mm. higher than the face, and marked by well-developed rows of hooked denticles that represent a diminished extension of the lateral costae. Lateral surfaces ornamented with closely-spaced longitudinal costae that may be divided into two sets, anterior and posterior. The total number of costae ranges from 25–26 on the inner end to 17–18 on the outer, with 21 midway between, the increase in number proximally being due to bifurcation. The anterior set or group of costae consists of 9–10 large costae concentric with the outer curvature, 0.5–0.75 mm. thick, pectinated by transverse tubercles of which 6–9 occur in a space of 5 mm. The tubercles are further pectinated by rounded ridges transverse to their long axes. The posterior set is formed by 8–15 narrower costae, 0.2–0.5 mm. thick, concentric with the posterior curvature, pectinated by irregularly fluted tubercles of which 5–6 occur in a space of 5 mm. The most posterior of the costae of this set spiral gently over the margin where their tubercles are hook-shaped.

Occurrence and Material.—Ames limestone, Conemaugh group, Upper Pennsylvanian, east central part of Section 22, 0.75 miles east of Claysville, Guernsey County, Ohio. One specimen, collected by R. E. Lamborn (O. S. U. Geol. Mus. No. 19501).

Remarks.—When collected the spine was almost wholly enclosed in a small block of limestone, from which it was freed by etching with acetic acid. It is imperfect and lacks the proximal and distal portions, but is so clearly distinguished by its form and sculpture that it should easily be recognized when collected in the future.

Three other species of *Ctenacanthus* have been described from the Pennsylvanian of this country: *C. amblyxiphias* Eastman (1903, p. 186, pl. 2, figs. 22, 23; *non* Cope, 1891, p. 449, pl. 28, figs. 3a-c, *nec* Branson, 1916, p. 654, pl. 2, fig. 25, text fig. 5) from the Missourian group (Atchison shales) of Nebraska; *C. buttersi* St. John and Worthen (1883, p. 240, pl. 22, fig. 2) from the "shales over Coal No. 5" in Illinois; and *C. marshi* Newberry (1873, p. 326, pl. 36, figs. 3-3b) from near Zanesville, Ohio. Of these, *C. marshi* is marked by coarse, seemingly smooth and unornamented lateral costae; the others have finer, ornamented costae. *C. buttersi* has different proportions—larger radius of curvature and triangular cross-section with the posterior width nearly equal to the height, and strongly tuberculated rather than smooth anterior costa on the cutwater edge.

C. amblyxiphias was originally described from the Permian of Texas by Cope (1891). Later Hussakof re-figured Cope's type, repeated his description but added nothing further (1911, p. 161, pl. 30, figs. 6-6a). In the meantime Eastman (1903) referred two fragmentary spines from the Missourian of Nebraska to the species, but gave no description of them. Branson identified the

species among the fish remains of the Ember formation (Permian) of Wyoming, and indicated that his specimens differed from Cope's in two respects: different ornamentation and no diminution of the costae posteriorly. However, study of Branson's figures suggests that there is a diminution in costal width posteriorly. As to the difference in ornamentation, it is unfortunate that he did not specify what that difference was, for his figures fail to show any, not being sufficiently enlarged.

C. lamborni, on the basis of Cope's description and figures and Hussakof's figure, has a costal arrangement and ornamentation like that of *C. amblyxiphias*, but they differ considerably in their cross-sectional proportions, as indicated by the following analysis:

	Transverse Posterior Diameter	Antero-Posterior Diameter	Ratio	Tubercles per 5 mm. on Larger Costae
C. amblyxiphias (Cope's descr.)	17 mm.	28 mm.	1 : 1.64	.....
C. amblyxiphias (Hussakof's fig.)	15	28	1 : 1.93	6
C. amblyxiphias (Eastman's fig.)	.....	.....	.....	5–8
C. amblyxiphias (Branson's reduced fig.)	4.5	11	1 : 2.44	.....
C. lamborni n. sp. (proximal)	11	26	1 : 2.34	6–9
C. lamborni n. sp. (distal)	6	15.5	1 : 2.6	

Eastman's *C. amblyxiphias* at present cannot be definitely placed until more data on its proportions be obtained, but it may be suggested that it is not the same as the Permian *C. amblyxiphias* but either closely allied to or even identical with *C. lamborni*.

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EXPLANATION OF PLATE I

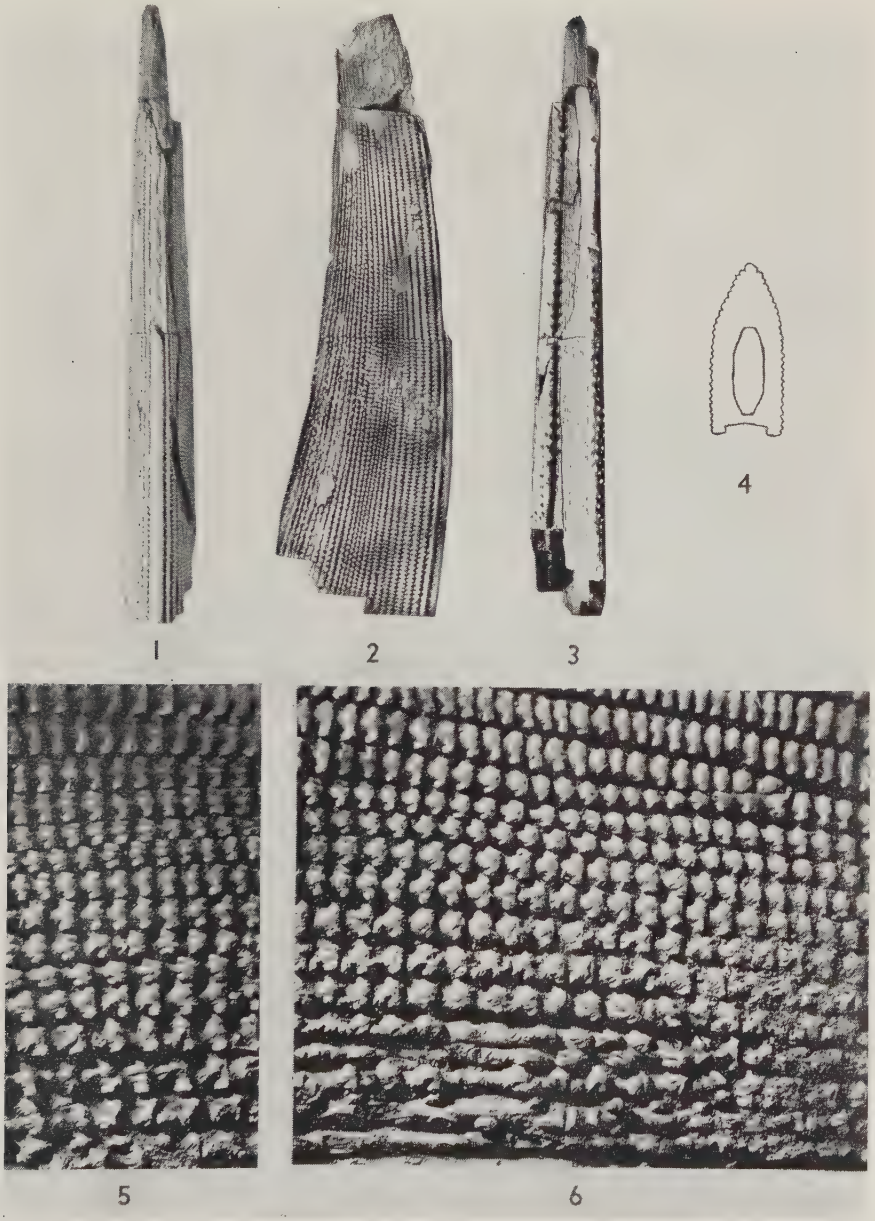
Ctenacanthus lamborni Wells, n. sp.

(All figures are of the holotype, O. S. U. 19501.)

1, 2, 3. Anterior, lateral, and posterior aspects, ×1.

4. Outline of cross-section of spine at end of preserved proximal portion, ×1.

5, 6. Surface ornamentation of lateral costae, ×6. In upper quarter of both figures are the larger costae of the anterior group with their strongly compressed, pectinated, transverse tuberculations; in the lower three-quarters are narrower costae of the posterior group with the tubercles losing their regularity posteriorly and becoming subconical.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THE WINTER FISHERY IN WESTERN LAKE ERIE, WITH A CENSUS OF THE 1942 CATCH

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Franz Theodore Stone Laboratory, The Ohio State University,
Put-In-Bay, Ohio

In the island region of western Lake Erie a hook and line fishery operates on a commercial basis during the period of a year when the lake is covered with ice in that vicinity. The center of this fishery is Put-In-Bay on South Bass Island. No nets are employed in this winter fishery.

The fish captured are of high quality and the catch is of sufficient magnitude to be of importance in the regional economy, although the quantity is but a small fraction of the annual yield of the whole lake. A creel census was placed in operation during the winter of 1942, and, when compared with returns of hook and line fishermen in other water areas, the yield was high.

HISTORY OF THE FISHERY

Presumably the earliest fur traders and settlers on the Lake Erie islands were familiar with the practice of fishing for food with hook and line through holes in the ice. Until about 1890 fishing was a casual affair, since not much effort was required to take ample supplies of herring, *Leucichthys artedi albus* (LeSueur), for domestic consumption. The fisherman squatted at the edge of a round hole in the ice and used a stick attached to which was a short line bearing a small hook baited with a pearl button or a piece of cloth. This type of fishing, confined mostly to the protected harbor, yielded ample supplies of jumbo herring averaging about 18 inches in length.

When shanties first came into use about 1890, they were built of wood and were heavy, semi-permanent structures that required considerable exertion to bring into position on the ice. With the adoption of the shanty, fishing extended out from the harbor to more exposed situations over deeper water. About 1895 the first shanty was built with a canvas covering over a wood frame. This newer and lighter shanty, mounted on runners, met with general favor so that in succeeding years the number on the ice increased from 50 to as many as 250 shanties. The first wooden shanties were frequently built with several holes in the floor, and accommodated up to half a dozen fishermen. The present canvas shanties are small, coal-heated, one-man shelters, but are occasionally large enough to hold two fishermen. The early fishing gear of two or three lines each with a single hook was modified, between 1910 and 1920, to the present standard equipment of two lines per man, each line with a heavy flat weight, a spreader, and two hooks.

Catches of fish in the early days were generally greater than at the present time. Notably abundant then were herring, a rarity in recent winter catches. Sauger, *Stizostedion c. canadense* (Smith), were taken more abundantly then than now, a fisherman sometimes catching in a day two bags of "clear" sauger (a catch composed of sauger only). Catches of perch, *Perca flavescens* (Mitchill), have always varied greatly throughout the years. The catch of three tons of No. 1 yellow pickerel, *Stizostedion v. vitreum* (Mitchill), in a single day was an outstanding event in 1910.

The sizes of fish caught have also varied. Large pickerel were more frequently encountered forty years ago than now, and fish of 9 and 10 pounds were common. One fisherman at that time caught in one day two very large pickerel, 17 and 18½

pounds; another caught four 12-pound pickerel before 9:00 A. M. and several 8- and 9-pound fish later the same day. Big sauger, now largely unknown, were quite usual. The size of perch has been maintained throughout the period of the fishery, generally at about three fish to the pound.

Fluctuations in market prices and demand have had an effect on the size of the catch. Sometimes in the 1890's fishermen were unable to sell their fish at any price; at other times in the same years they accepted ¾c. pound for perch, 1c. pound for sauger, and 3c. pound for pickerel and herring. In later years as many as five buyers competed for the catch, and prices were forced higher. During the war of 1914–1918, prices of pickerel reached a peak of 20–25c. pound. In 1942 fishermen received 10c. pound for perch and sauger, 12c. pound for No. 2 pickerel, and 14c. pound for the larger No. 1 pickerel.

The hauling of local wines to the mainland and city markets by teams and sleighs was formerly an important winter industry on the islands, but fish were regarded as of minor importance as a freight load. With intermittent hauling facilities, fishermen were not assured of steady marketing of their fish, and the fishing industry did not become stabilized.

Beginning about 1900, mail, passengers, and freight including fish were carried to the mainland in winter by regular contractors who used iron-clad boats capable of travel over both water and ice. Regularly scheduled trips could be depended upon, except during violent extremes of weather, and additional iron-clads were put into service solely for the fish trade. Two men could carry four 250-pound barrels of fish in one boat, and sometimes completed three round trips daily to the mainland, about 3½ miles distant. The fish-carrying ironclads occasionally transported as much as three tons of fish daily, and the winter fishing industry thus proceeded on a firmer basis.

The final development in the improvement of the island fishing industry was the permanent establishment of an airplane freight service which has carried fish dependably and continuously each winter since 1931–32.

Before the present century fish were readily available, but, owing to low prices, daily incomes generally amounted to $3 or $4, and sometimes up to $7 per fisherman. The wages of the men engaged in the transportation of fish were about the same as those of the fishermen. More recently, even with satisfactory ice conditions, fish have sometimes been caught with greater difficulty; fifty days of fishing in 1933 resulted in earnings of $57 for one fisherman. At other times the fortuitous combination of moderate numbers of fish with high prices has resulted in individuals making catches of outstanding value: $78-worth of fish in three days, and $31 in one day are instanced.

Yellow pickerel, perch, sauger and herring have constituted the chief species entering the fishery, and in some seasons there has been a market for lawyers, *Lota lota maculosa* (LeSueur), but the fishermen were required to dress these fish before the buyers would accept them at 1c. pound. Herring have been of no importance for about the last twenty years.

The capture of lake shiners, *Notropis a. atherinoides* Raf., for bait has generally been simple, as they were usually plentiful and readily available. Sometimes shiners were so abundant that fishermen did not bother to keep a live-box, but in the morning on the way out to the shanty stopped in a bay where in a few minutes they would easily catch a day's supply with a few hauls of a circular dip net through a hole in the ice. At other times shiners were more difficult to catch, and their extreme scarcity in 1912 was paralleled by that in 1942. The catching of shiners for bait has been a commercial effort by one or two men each year, and prices have been as high as $2 quart, but average about 50c. quart, there being approximately 400 shiners in a quart.

THE CENSUS

Methods—

In most creel census operations it has been customary for the census-taker either to talk with the fishermen while they were angling, to meet the fishermen at a dock or other point of egress from the fishing waters, or to set up census stations at points about the lake where cards were available for the voluntary use of anglers. In this census, the practice of obtaining data has been simplified because most of the catches eventually passed through the hands of only two buyers, and both have furnished records of the number of pounds of fish purchased each day.

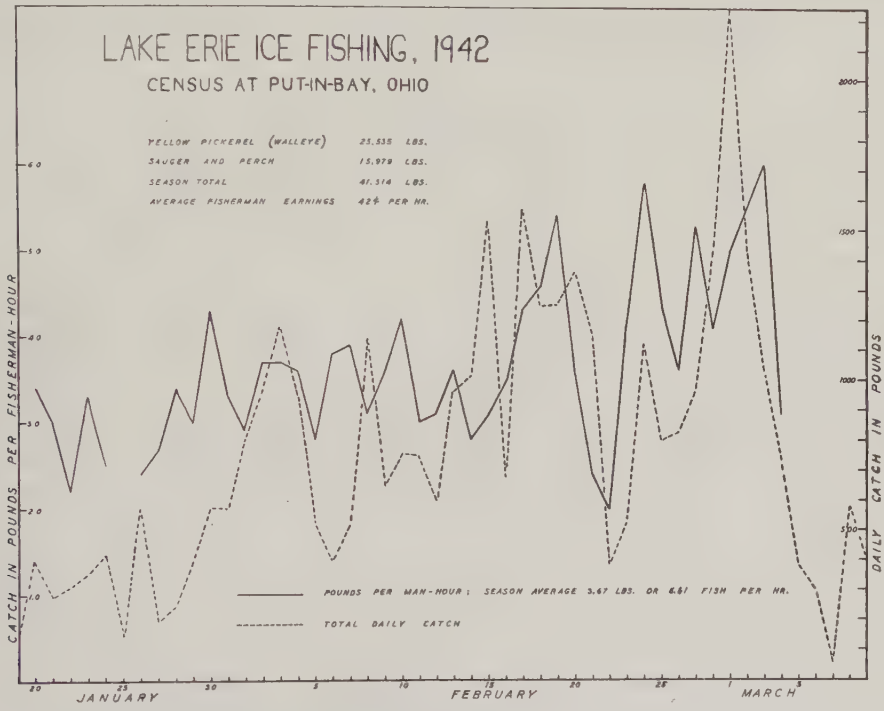
LAKE ERIE ICE FISHING, 1942
CENSUS AT PUT-IN-BAY, OHIO
YELLOW PICKEREL (WALLEYE) 25,535 LBS.
SAUGER AND PERCH 15,979 LBS.
SEASON TOTAL 41,514 LBS.
AVERAGE FISHERMAN EARNINGS 42¢ PER HR.
CATCH IN POUNDS PER FISHERMAN-HOUR
DAILY CATCH IN POUNDS
POUNDS PER MAN-HOUR; SEASON AVERAGE 3.67 LBS. OR 6.81 FISH PER HR.
TOTAL DAILY CATCH
JANUARY
FEBRUARY
MARCH

FIGURE 1. Graph showing fluctuations in daily total catch and in daily catch per man-hour in the winter hook and line fishery. Yields increased irregularly with progress of the season.

The Port Clinton Fish Company purchased about 65 per cent of the total catch, and collected data for 58 per cent of the total catch on the number of hours occupied by each fisherman to catch the fish which he offered for sale. It is these data which form the basis for calculations of effort. Effort refers to the number of pounds of fish caught per man-hour; perhaps it should more properly refer to the time required to catch a unit weight of fish, but the former definition of the term has been adopted in this report.

In the calculation of a daily average of effort, two procedures could be used. The first would be to find the simple mean of individual efforts for the day; this might be regarded as a better measure of availability, since it does not give undue weight to either the poor or successful fisherman. The second method would be to calculate the daily mean effort by weighting individual efforts according to the number of hours fished; or, in practice, to divide the total catch for the day by

the total number of hours fished. This mean could be construed as a true measure of the average return per hour for all fishing.

Since this report may possibly have more value if calculations are based on the average return per hour for all fishing, the weighted mean has been used. However, simple means have also been calculated, but the two means have not differed by more than 0.39 pounds per hour, of total catch, on any one day, and have differed by less than 0.10 pound per hour throughout 64 per cent of the season. Weighted averages have also been employed in the comparison of catches over periods of several days or weeks, and in the treatment of financial returns to the angler.

The poundages of fish listed in Table I do not indicate the total yield. Fish that were sold conformed to minimum size limits of one pound for No. 1 pickerel (about 15 inches total length), 13 inches for No. 2 pickerel, 11 inches for sauger,

TABLE I

HOOK AND LINE CATCHES IN THE WINTER FISHERY IN LAKE ERIE AT PUT-IN-BAY, OHIO, FROM JANUARY 17 TO MARCH 13, 1942.

MONTH	CATCH IN POUNDS, AS REPORTED BY DEALERS							
	YELLOW PICKEREL				SAUGER	PERCH	NOT SPECIFIED SAUGER AND PERCH	TOTAL CATCH
	No. 1	No. 2	Not Specified	Total				
January	661	2,295	1,227	4,183	271	703	623	5,780
February	1,503	14,132	.....	15,635	3,700	4,077	3,147	26,559
March	920	4,797	.....	5,717	907	1,018	1,533	9,175
Totals	3,084	21,224	1,227	25,535	4,878	5,798	5,303	41,514
Per cent of total catch	7.4	51.1	3.0	61.5	11.8	14.0	12.8	

and 8 inches total length for perch. Undersized fish were taken for home use, and non-resident sportsmen also caught a proportion of the total yield; however, the fish not offered for sale probably constituted not more than 20 per cent of the total catch, or about four tons. Because buyers paid the same price for sauger and perch, poundages of these fish were generally listed together on the sales slips,[1] so that efforts for these species individually were not available throughout the season.[2]

Catch—

The winter catch of fish in Lake Erie at Put-In-Bay, as reported by commercial dealers, has averaged about 44,500 pounds from 1935 to 1940, and has been composed of 70 per cent pickerel, 24 per cent perch, and 6 per cent sauger. During this period the winter catch of pickerel, perch, and sauger has amounted to 1.04, 0.31, and 0.23 per cent, respectively, of the annual catch of these three species by commercial nets in the Ohio portion of Lake Erie.

[1]Blue pike, *Stizostedion vitreum glaucum* Hubbs, were taken in small amounts, and have been included with sauger.

[2]Total catches, apart from the data on effort, were obtainable by species.

The winter fishing season in 1942, as regulated by the period of ice-cover on the lake, extended from January 17 to March 13, and data on effort are available between January 20 and March 4, for which catches, efforts, and fishermen's earnings are presented in Tables I and II.

The trend of success in fishing evidenced an irregular increase from a minimum average catch of 2 pounds per hour of all species near the beginning of the season to a maximum daily average of 6 pounds per hour in early March, as shown in Figure 1. The season's average rate of catch was 3.67 pounds per fisherman-hour.

Yellow pickerel constituted 61.5 per cent of the total yield of the winter fishery in 1942, and these fish were taken at the rate of 2.34 pounds per hour (2.03 pounds

TABLE II

AVERAGE FISHING EFFORTS IN THE WINTER HOOK AND LINE FISHERY IN LAKE ERIE AT PUT-IN-BAY, OHIO, 1942.

	Number of Fisherman Reports	Average Length of Fisherman-day, in Hours	Yellow Pickerel			Sauger	Perch	Sauger and Perch	Total, All Species	Average Fisherman Earnings Per Hour
			No. 1	No. 2	Total					
Pounds of fish caught per fisherman hour.										
Jan. 20–Jan. 31..	116	8.1	0.51	1.90	2.41	.....	.....	0.67	3.08	$0.368
Feb. 1–Feb. 15..	307	8.3	0.23	1.70	1.92	.....	.....	1.37	3.29	0.374
Feb. 16–Feb. 28.	274	8.5	0.23	2.22	2.44	.....	.....	1.49	3.94	0.448
Mar. 1–Mar. 4...	77	8.9	0.59	2.88	3.47	.....	.....	1.51	4.98	0.575
Season total, or average.....	774	8.4	0.31	2.03	2.34	.....	.....	1.33	3.67	0.421
Average weight per fish, in lbs..	.....	.....	1.54	0.70	.....	0.46	0.33	.....	.....	.....
Calculated number of fish caught per fisherman-hour..... (Season average)	.....	.....	0.20	2.90	.....	1.33	2.18	.....	6.61	.....

per hour of No. 2, and 0.31 pounds per hour of No. 1 pickerel). Perch and sauger, which composed the remaining 38.6 per cent of the total catch, were together caught at the rate of 1.33 pounds per hour.

COMPARISON WITH HOOK AND LINE FISHING IN OTHER LAKES

Many creel censuses have expressed the results in fish per hour, without conversion into the more comparable expression of rate of catch in pounds. It is generally safe to assume that for most fishing areas the figure representing catch in fish per hour is greater than that of catch in pounds per hour.

Fishing in a group of Michigan lakes yielded average catches of 0.4 fish per hour and 1.1 fish per hour in summer (Hazzard and Eschmeyer, 1937); winter catches in several other lakes in Michigan varied between 0.1 and 1.7 fish per hour, and summer catches in the same lakes from 0.4 to 2.5 fish per hour (Hazzard and Eschmeyer, 1938). Surveys in seven Ohio lakes showed catches of 1.30 to 4.77 fish per hour in summer and autumn (Wickliff, 1936). Catches in the spring, summer and autumn in some Wisconsin lakes have been reported at the rate of

1.24 to 1.86 fish per hour (Frey, Pedracine, and Vike, 1939), and 0.90 to 1.53 pounds per hour (Frey and Vike, 1941). Fish have been taken in the summer by anglers in several Algonquin Park lakes, Ontario, at the rate of 0.66 to 2.56 fish per man-hour (Hart, 1941), and at rates of 0.54 to 3.20 fish per boat-hour (Kennedy and Banfield, 1942).

Spring and summer fishing in Illinois have yielded results of 4.37 fish per hour (Bennett, Thompson, and Parr, 1940). Angling throughout the year, or portions of it, in several reservoirs and their tributaries in Alabama and Tennessee gave catches of 0.2 to 1.4 fish per hour (Eschmeyer and Tarzwell, 1941; Tarzwell, 1941).

The average daily catch made by hook and line fishermen operating through the ice in the island section of western Lake Erie amounted to 3.67 pounds, or 6.61 fish, per fisherman-hour between January 20 and March 4, 1942. In general, this is a higher rate of return to the angler than in most fisheries elsewhere and in various seasons of a year.

ACKNOWLEDGMENTS

The creel census was conducted under the direction of Dr. T. H. Langlois, and with the cooperation of other members of the staff of the Laboratory. Assistance in the collection of data was received from the Ohio Division of Conservation and Natural Resources. The author is indebted to Drs. W. E. Ricker and R. Hile for discussion of weighted and simple means in the measure of fishing effort.

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—*L. H. Snyder.*

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SANDSTONES AND CONGLOMERATES IN OHIO

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Introduction

The pioneer settlers, mainly through necessity, first turned the local sandstones in the eastern half of Ohio to profitable account in the construction of homes, mills, factories, dams, bridges, canal locks, furnaces, cupolas, public buildings, etc. Such rocks were widely distributed over that area, had outcrop exposures favorable for quarrying, were readily fashioned by the mason into desired forms and, in general, were pleasing to the eye or appealed to the sense of durability. The first homes were built of logs but in these the chimneys most commonly were constructed of sandstones laid in mud. For example at Schoenbrun, established by the Moravians in 1792 and burned soon after by the whites, the locations of the old buildings were established by the hearthstones and the corner foundations hid during the lapse of time. The dams of early mills, built from 1790 on, used rock of some kind for the entire structure, for the shore anchors or for weighting the timbers if made of wood. Piles of moldering sandstones still mark the sites of Hopewell furnace built in 1804, Montgomery in 1806, Rebecca in 1807, Licking in 1808, etc. The remaining evidence for the first paper mill west of the Allegheny Mountains, and built on the Little Beaver Creek in 1805, is remnants of the stone abutments on the shores and a row of holes in the rocks forming the floor of the stream. Such instances may be duplicated many, many times and with a wide variety of older works.

Definition of Terms

Sandstone may be defined as a rock of sedimentary origin derived by consolidation of sand through compaction and cementation by bonding components. The sand grains may be nearly pure quartz or quartz with feldspar, mica, zircon, rutile, garnet and other minerals. In size the grains may vary from fine to coarse but in any given rock they are usually rather well sorted. The common bonding components are iron oxides in some form, silica, either amorphous or crystalline, and carbonates of calcium and magnesium. Others less abundant but common are phosphates, organic matter and manganese oxide.

Conglomerate is a consolidated water-lain rock made up partially or nearly wholly of pebbles, usually rounded, embedded in a matrix of finer material, generally sand. The pebbles may be derived from most any kind of hard rock but those from quartz or quartzite are the most common. Usually the conglomerate rock is a massive stratum varying both vertically and laterally from a sandstone with few pebbles to one made up largely of the coarse material, the sand filling only interstitial space. Cross-bedding and lenticularity are conspicuous features of most conglomerates when viewed in mass.

General Occurrence

In Ohio sandstones and conglomerates occur at various horizons throughout the entire rock column of some 6,800 feet from the basement pre-Cambrian crystallines to the upper-most strata of the Permian system. However, the quantity of such strata varies greatly in the different systems being abundant in some and nearly absent in others. On account of so much variation and so many wants with the sandstones and conglomerates a true estimate is hardly possible. However, the data given below are relatively accurate.

System	Total Thickness of Rocks, Feet	Total Thickness of Sandstone and Conglomerate, Feet
Permian	626	147
Pennsylvanian	1,115	355
Mississippian	675	375
Devonian	770	5 ?
Silurian	800	20
Ordovician	2,095	0 ?
Cambrian	720	360
	6,801	1,105

Thus an abundance of siliceous strata is present in the Mississippian, Pennsylvanian, Permian and Cambrian systems whereas an impoverishment of such materials prevails in the Ordovician, Devonian and Silurian systems, the latter three being made up of dolomites and limestones with minor quantities of shale.

Cambrian System

In the Vance[1] and some ten other wells in the western half of Ohio that have penetrated the strata from the base of the great Trenton-Black River group to the crystalline gneisses and schists many sandstone lenses, some quite thick, are inter-

[1]See "Paleozoic and pre-Cambrian Rocks of the Vance Well, Delaware County, Ohio," by Wilber Stout and Carl A. Lamey, The Bulletin of The American Association of Petroleum Geologists, Vol. 24, No. 4, April, 1940, page 687.

spersed in dolomite in the basal 720 feet or more of the section. Here, the sandstones, either pure or dolomite bonded, make up more than half of the deposits. In the Vance and also in a few of the other wells with detailed sections, the sandstone most conspicuous lies directly above the crystalline rocks, is exceptionally pure and measures 125 feet or more in thickness. These sandstones provide excellent reservoirs for the accumulation of petroleum, natural gas and brine but so far they have yielded only the latter. The brine[2] is highly concentrated and is of value for the chemical industries. In the Vance well it was found at a depth of 3,820–3,825 feet.

Ordovician System

The rocks of the Ordovician system, some 2,095 feet in thickness, are nearly entirely dolomites, limestones and calcareous shales. The only well known and definitely correlated sandstone in the system is the St. Peter lying at the base of the Black River formation. However, this member is largely wanting and when present thin and impure. The horizon yields a weak brine and the green shale and dolomite, 10 to 15 feet above the disconformity, have furnished in scattered wells small quantities of petroleum and natural gas.

Silurian System

Throughout this great system of rocks, about 800 feet in thickness, the dominating deposits are dolomites, calcareous shales and limestones, many of which are of great interest industrially. The only sandstone of any importance is the Clinton of the driller which is of Medina age and correlative with the Whirlpool sandstone of the Niagara Gorge (New York) section.

Clinton Sandstone

The Clinton sandstone of the driller in Ohio is of Medina age and is correlative with the Whirlpool sandstone of the Niagara Gorge (New York) section. Its position is directly above the Elkhorn or Queenstown or "Red Medina" shale and from 100 to 250 feet below the base of the well known Niagara dolomites. This formation enters Ohio from the east or northeast, thins rapidly westward and becomes absent or very indefinite in the east central part. Its western boundary is marked roughly by a line from Lorain on Lake Erie through Mansfield, Mount Vernon, Lancaster, Laurelville and Jackson to Ironton on the Ohio River. It is not known on the outcrop in southwestern Ohio. The Clinton sandstone varies from 1 to 100 feet or more in thickness, is always fine in texture and in the eastern part of the state is cemented to a hard quartzitic rock. However this sandstone is the reservoir for the great natural gas and petroleum fields stretching nearly continuously from Cuyahoga and Lorain counties on the north to Lawrence County on the south. Throughout the field, opened near Lancaster in 1887 and still active, over 26,000 wells have been drilled yielding immense volumes of natural gas and large supplies of petroleum. It has proved one of the most valuable formations in Ohio.[3]

Devonian System

The rocks of the Devonian system in Ohio are all of marine origin, average between 700 and 800 feet in thickness and include, in order of abundance, shale, limestone, dolomite and sandstone, the latter forming a very minor part of the

[2] *Ibid.* Pages 673–4.

[3] For reference see: Geol. Sur. Ohio, Vol. VI, pages 12, 75, 354 and 783; Geol. Surv. Ohio, Bull. 1, "The Occurrence and Exploitation of Petroleum and Natural Gas in Ohio," pages 20, 101, 120; Geol. Sur. Ohio, Bull. 12, "The Bremen Oil Field," pages 16, 17, 22, 23, 24, 38, 65; also Bulletins 20, 21, 24, 28, 31, 35, 37.

whole. The siliceous strata comprise the Oriskany sandstone at the base of the system and the Marcellus, Olentangy and Ohio shales in the middle and upper portions.

ORISKANY SANDSTONE

The type locality for the Oriskany sandstone is Oriskany Falls, Oneida County, New York. The formation extends westward from New York through Pennsylvania into eastern Ohio, becomes absent in the central part of the State but appears again in the northwestern portion. In the latter area it is known as the Sylvania sandstone. The formation is erratic in thickness varying from 1 to 100 feet but ranging usually between 10 and 40 feet. Its chief economic value is for the production of natural gas and petroleum, the chief fields being in Ashtabula, Tuscarawas, Guernsey, Coshocton and Muskingum Counties. Formerly the Sylvania sandstone of northwest Ohio was used in glass making and was ground to a fine powder for potters flint, paint pigment and foundry uses.[4]

Mississippian System

Aside from the Maxville limestone placed at the top of the section but absent over much of the area the rocks of the Mississippian system are entirely siliceous in character, that is, they are sandstones or siliceous shales. The total thickness of these strata varies from place to place but on the average approximates 675 feet. The deposits are wholly marine in origin and show much evidence of shallow water deposition. The system outcrops in a wide belt extending northward from Scioto County on the Ohio River to Lorain and Medina Counties thence eastward to Trumbull County on the Ohio-Pennsylvania line. The shales are employed extensively for ceramic products and the sandstones have proved useful for building stone, abrasives, oil and gas, brines, fire stone, glass sand and molding sand.

EUCLID SANDSTONE

Although the Bedford formation primarily is shale yet in some areas it bears thin to medium bedded layers of sandstone either closely or widely spaced in the shale. In the Cleveland district this sandstone has long been quarried under the name of "Euclid bluestone," is dense and fine grained and weather resistant. The deposits range from 15 to 30 feet in thickness and the individual layers from 2 inches to 3 feet 6 inches. It finds employment for flagging, foundations, cellars and when sawed for caps, sills and steps.[5]

BEREA SANDSTONE

The Berea sandstone of Mississippian age, and named by Newberry in 1870, is one of the best known rocks of this class in Ohio. It is important along the outcrop as a source of building stones and abrasives and under deep covering as a storage reservoir for petroleum, natural gas and salt brines. The formation expands 5 to 225 feet in thickness but averages about 45 feet. The typical stone is massive in structure, medium fine in grain size, rather open in texture and light gray to slight buff in color. It quarries with good economy and works well either by chipping or sawing. The outcrop of the Berea sandstone is marked in a general way by small or large quarries in Trumbull, Ashtabula, Geauga, Lake, Cuyahoga, Lorain, Erie, Huron, Crawford, Morrow, Delaware, Franklin, Pickaway, Ross, Pike, Scioto and Adams Counties. The most prominent quarries are confined to

[4]For reference see: American Association of Petroleum Geologists, "Natural Gas in Central and Eastern Ohio," June, 1935, page 907.

[5]For detail see: "Geology and Mineral Resources of the Cleveland District," U. S. Geol. Sur. Bull. 818, pages 107–111; "The Devonian and Mississippian Formations of Northeastern Ohio," Geol. Sur. Ohio, Bull. 15, page 51; "Building Stones of Ohio," Geol. Sur. Ohio, Bull. 18, pages 69–70.

northern Ohio in Lorain, Cuyahoga and Erie Counties. The uses of the Berea sandstone are many, principal among them are building stone, curbing, flagging and riprap. It is the chief source in the United States for grindstones, whetstones and related rubbing stones. Formerly it was used for mill stones for grinding barley and other grains. Of recent years a new and important use is sawed stone for refractory linings of cupolas, in replacement of silica brick. Such blocks are cheap, stand up well against heat and slag and are easily replaced.

The Berea sandstone ranks third in the production of petroleum and natural gas, being surpassed only by the Trenton and the Clinton. From the Berea the yield has been largely oil. The depth of the wells varies from 100 to 2,000 feet or more. On the average the wells are not large producers but are long lived. The largest pools are in Athens, Washington, Perry, Morgan, Muskingum, Noble, Monroe, Belmont, Harrison, Jefferson, Carroll, Columbiana and Mahoning Counties. Some production is also obtained in Gallia, Meigs, Vinton, Hocking, Guernsey, Coshocton, Tuscarawas, Holmes and Stark Counties. This formation is a consistent producer of brine except where structural relief is such as to impede its migration. The flow of brine, however, is not large nor is the concentration especially strong, the yield of salts in the brine varies greatly but commonly ranges from 50 to 150 grams per liter. Formerly brine from the Berea sandstone was utilized for salt making near Dover in Tuscarawas County and at Lisbon and Salineville in Columbiana County.[6]

BUENA VISTA SANDSTONES

The Buena Vista formation is recognized as such from the Ohio River in Adams County northward to near Mansfield in Richland County, beyond which it breaks up and becomes more indefinite. It is made up of a great series of sandstone and shale layers occupying from 100 to 150 feet of the lower part of the Cuyahoga formation. Such deposits are best developed in western Scioto, eastern Adams and western Pike Counties. The sandstone beds vary from one inch to six feet in thickness, but the majority are under 16 inches. Further, they maintain remarkable regularity in their lateral extension. These sandstones are fine in texture, break well in any direction, are bluish-gray to rich brown in color and are firmly cemented with clay matter and iron oxides. At present the active quarrying is largely confined to McDermott in Scioto County. Formerly, however, the deposits were worked in a large way at Buena Vista, Rarden, Henly, and Carey Run in Scioto County, Piketon and Waverly in Pike County, at Lithopolis in Fairfield County, and Blacklick in Franklin County. In southern Ohio the output consists of sawed stone for building, grave vault, flagging, curbing purposes and perch stone for bridges, abutments, retaining walls and foundations.

The Buena Vista sandstones also produce petroleum and natural gas, especially the latter, under the driller's term of Hamden sand of Jackson and Vinton Counties, Weir of West Virginia and Welsh Stray of Monroe County. In Ohio the outstanding gas pool is near Hamden in Vinton and Jackson Counties.[7]

BLACK HAND SANDSTONE

The Black Hand formation forms conspicuous deposits along the outcrop in central Ohio from southwestern Hocking County through Fairfield, Licking and Knox Counties to north of Mansfield in Richland County. Further it extends

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[6]References: Geol. Sur. Ohio, Bull. 18, "Building Stones of Ohio," pages 72–118; Geol. Sur. Ohio, Bull. 1, "The Occurrence and Exploitation of Petroleum and Natural Gas in Ohio," many references; The American Association of Petroleum Geologists, June, 1935, pages 904–5; Geol. Sur. Ohio, Bull. 37, pages 14–16, 52–63.

[7]Geol. Sur. Ohio, Bull. 18, "Building Stones," pages 108, 122–129; Bull. 23, "Geology of Camp Sherman Quadrangle," pages 104, 113, 156.

on southeastward under deep covering into West Virginia as shown by the drill. It is a massive deposit, often one great ledge with few if any distinct stratification planes. It varies in thickness from 50 to 200 feet or more. The stone changes in texture from a coarse-grained sandstone to a rather pebbly conglomerate. Commonly, however, it is a sandstone with pebbles scattered through the mass or concentrated to local lenticular layers. The stone is generally highly cross-bedded, the planes being confined to definite lenticular boundaries which are rather closely spaced. Outstanding features are thus cross-bedding and lenticularity. The usual cementing medium is iron oxides. This sandstone is commonly of a decided buff color but locally this changes to light, light gray, pink, reddish and brown.

This sandstone has been used since pioneer days but in a rather desultory way for building stone and heavy masonry. It has been quarried for such purposes near Mansfield in Richland County, along the Licking River at Hanover and Toboso in Licking County, along the Hocking River at Lancaster and Sugar Grove in Fairfield County and at Rockbridge and Logan in Hocking County. Through crushing followed by screening, air separation or washing, the Black Hand sandstone finds employment on the markets for molding sand, mortar sand, sand finish of plastering, sand blasting, engine sand and glass sand. The largest active plant (1943) is at Millwood in Knox County, preparing glass sand by acid treatment and washing.

To the driller the Black Hand sandstone is known as the Big Injun sand. When detached from the main body the lower portion is called the Squaw sand. These sandstones produce both petroleum and natural gas, but largely the latter. The Big Injun sand is of most importance in Washington and Monroe Counties and of less worth in Athens, Vinton, Morgan, Muskingum, Noble, Guernsey and Belmont Counties.

In the Pomeroy district of Meigs County the Black Hand sandstone is one of the important sources of brine for the salt industry. Formerly such brines were used extensively along the Hocking River and along Sunday Creek in northern Athens County and along the Muskingum River in southern Muskingum and northern Morgan counties. This formation yields a large flow of concentrated brine which is high in bromine and practically free from sulphates.

The Black Hand sandstone is of value also for the picturesque and attractive scenery presented along the outcrop. The deeply entrenched gorges, box caverns, falls and cascades and bold cliffs yield recreation places and camp sites of value for scenery, wild life and pleasure. Ash Cave, Cedar Falls, Old Man's Cave, Conkle Hollow, Rock House, Cantwell Cliffs, Clear Fork, Jacob's Ladder, Christmas Rock, Mt. Pleasant, Licking Narrows, Rain Rock and Kokosing gorge are some of the outstanding spots that may be mentioned.[8]

BYER SANDSTONE

The Byer sandstone belongs near the base of the Logan series of the Mississippian system. This formation at the type locality, Byer in northern Jackson County, is a fine grained, even bedded sandstone of a yellowish or buff color. The bonding components, consisting of clay matter and iron oxides, are rather high, but the stone is only locally weather resistant. In many areas more or less of the sandstone is replaced by gray siliceous shale. The thickness of the Byer formation is about 60 feet in Scioto County, 70 feet in Vinton, 100 feet in Ross and 70 feet in Wayne. Economically it is of small worth, supplying only small quantities of building stone for local needs.[9]

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[8]For reference see: Geol. Sur. Ohio, Bull. 37, "Brines of Ohio," pages 22, 23, 47-52; Bull. 18, "Building Stones," pages 140–142; American Journal of Science and Arts, 3rd series, Vol. XVI, 1878, pages 216–217.

[9]For references see: Geol. Sur. of Ohio, Bull. 23, page 154; Bull. 31, pages 52–53.

ALLENSVILLE CONGLOMERATE

The Allensville conglomerate, named by Hyde for the village of Allensville in western Vinton County, is the third unit in the Logan series of the Mississippian system. It is quite distinctive in that it is a fine but very even-grained conglomerate, in size about like wheat grains. It may occur in one or in two distinct beds in sandstone and siliceous shale of the ordinary Waverly types. In thickness the conglomerate zones vary from one inch to four feet and that of the entire member from 2 to 25 feet. The Allensville formation is recognized along the outcrop from Scioto to Summit County. If present in larger quantities the well sorted Allensville conglomerate would be useful for several purposes.[10]

VINTON SANDSTONE

The youngest deposits in the Waverly group of rocks of Mississippian age are those of the Vinton formation which was named by Hyde for exposures in the western part of Vinton County. In this area it is made up of a series of sandstones and shales, but elsewhere it may vary from massive sandstones with little or no shale to shales with only thin lenses of sandstone. The sandstones, commonly, are fine grained, thin to massive bedded and gray to drab in color. The thickness of the formation varies from 5 to 180 feet, depending on the amount left by the erosion cycle at the close of Mississippian time. Under deep covering in eastern Ohio the Vinton sandstone becomes the Keener sand of the driller and is very important as a source of petroleum and natural gas in Jefferson, Belmont, Monroe, Harrison, Washington, Noble and Morgan counties. It also contains brine but so far this has not been utilized for commercial purposes.

Pennsylvanian System

The great group of rocks now placed in the Pennsylvanian system was first defined, in 1838, in Pennsylvania, by Henry D. Rogers in work done for the United States Government. It has been and is of enormous importance in the Appalachian field for its coals, clays, shales, sandstones, limestones, iron ore, petroleum, natural gas and brines. Throughout this field Pennsylvanian rocks cover an area of more than 70,800 square miles in central and western Pennsylvania, eastern Ohio, western Maryland, western Virginia, West Virginia, eastern Kentucky, eastern Tennessee and northern Alabama. In Ohio such strata are found over an area of approximately 12,340 square miles. The Pennsylvanian system is sub-divided into four series, Pottsville, Allegheny, Conemaugh and Monongahela.

POTTSVILLE SERIES

The Pottsville is the basal series of the Pennsylvanian system and is of vast importance for its mineral resources. The total area of such rocks appearing at the surface in Ohio is not far from 3,760 square miles. It extends over parts or all of Trumbull, Mahoning, Geauga, Cuyahoga, Medina, Summit, Portage, Wayne, Stark, Holmes, Tuscarawas, Knox, Coshocton, Licking, Muskingum, Perry, Fairfield, Hocking, Vinton, Pike, Jackson, Scioto and Lawrence Counties. This formation averages about 255 feet in thickness but varies, on account of disconformities, between 175 and 400 feet. The Pottsville series comprises all the strata from the Mississippian rocks to the base of the Brookville coal. The recognized and named strata include 12 coal beds, 13 clays, 7 iron ores, 12 sandstones, 1 conglomerate and numerous shales. Here only the Sharon conglomerate and the Massillon and Homewood sandstones need be considered as of more than ordinary interest.

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[10]See references: Geol. Sur. Ohio, Bull. 23, page 154; Bull. 31, pages 53–55.

SHARON CONGLOMERATE

The Sharon conglomerate at the base of the Pottsville series is one of the outstanding deposits of Ohio. It is of interest for its geological history, for its physiographic and scenic features, for the many uses to which it is applied and for its storage and yield of petroleum, natural gas, salt brine and rock water. The stone varies in composition from a medium-grained sandstone to a coarse pebbly conglomerate, very loosely cemented. The deposits always occupy broad, deep depressions, resembling erosion valleys, cut in the older Mississippian floor. The deposits are very erratic in distribution and vary from 10 to 250 feet in thickness. The pebbles are vein quartz with a high purity. They were derived from the Canadian granite and gneiss fields to the north and after passing through long cycles of weathering and transportation came to rest in great beds in Ohio and in areas in adjacent states. In southern Ohio the main fields are in eastern Scioto, eastern Pike and western Jackson Counties and in the northern part of the State in eastern Wayne, Stark, Mahoning, southern Trumbull, Portage, Summit, eastern Medina, southeastern Cuyahoga and Geauga Counties.

The Sharon conglomerate is the Maxton sand of the driller and in southeastern Ohio yields petroleum and natural gas, also brine of fair strength. Where present in good development along the outcrop it is an excellent source for rock water and for springs, some unusual. It provides also much scenic beauty in both southern and northern Ohio such as Rock Run, White's Gulch, Canter's Cave, Big Rock, Nelson Ledges, Thompson Ledges, Boston Ledges, Cuyahoga Falls and Little Mountain. The Sharon conglomerate is of economic importance for the manufacture of silica brick, for reduction to the metal silicon, for pebble aggregate for nitrating plants, for paper, stucco work and sand blasting. Some glass and foundry sand are produced from selected material. Locally it is used for road facing, concrete work and railroad ballast.

MASSILLON SANDSTONE

The Massillon sandstone extends with some wants across the State from Youngstown in Mahoning County to the Ohio River in eastern Scioto County. It forms prominent exposures in Scioto, Jackson, Vinton, Hocking, Perry, Muskingum, Coshocton, Holmes, Wayne, Stark and Mahoning Counties. Stratigraphically the position of the Massillon sandstone is in the lower part of the Pottsville series, not far above the Quakertown coal. The thickness of the formation varies from 5 to 60 feet but the general measurement is between 20 and 45 feet. This member is usually massive in character, being broken by few bedding planes of sharp definition. Commonly it is conspicuously cross bedded, indicating its origin in shallow water with movement as along seashores. In texture it varies from a fine grained sandstone to one quite coarse or pebbly. The stone normally is light gray in color but through weathering it attains shades of drab, pink, brown and even variegated. Locally the Massillon sandstone is used in a large way for building stone for both light and heavy masonry. It is suitable also for glass sand, core sand, abrasives, etc. Under shallow covering it yields excellent supplies of water both for farm and home consumption and for industrial purposes. The Massillon correlates with the First Salt Sand of the driller and under deep covering in southeastern Ohio yields petroleum, natural gas and brine.

HOMEWOOD SANDSTONE

The Homewood sandstone is erratically developed along the line of outcrop across the state from Mahoning County on the east to Scioto and Lawrence Counties on the south. Its stratigraphic position is best defined as lying between the Upper Mercer and the Putnam Hill limestones, not uncommonly filling most of the interval. The thickness of the member varies from 5 to 60 feet. Where well

developed this sandstone occurs in massive ledges broken by irregular and widely spaced bedding planes and by vertical joints. It is somewhat cross-bedded, but shows little tendency to part, on weathering, along these planes. The Homewood is commonly a fine-textured sandstone. It is composed in the main of well rounded quartz grains admixed with a noticeable quantity of mica flakes. The bonding components are iron oxides and clay matter. The normal color of the stone is rather pleasing, ranging from light gray to soft drab shales. In Ohio the Homewood sandstone has been worked most largely around Zanesville where it was employed for years for foundations, retaining walls, culverts, steps, walks and house trimmings.

ALLEGHENY SERIES

The Allegheny series in Ohio is of special importance for its great clay beds and for its thick and persistent coals and is of some value for its iron ores, shales, sandstones and limestones. This series of rocks begins at the base of the Brookville coal and includes all the strata to the top of the Upper Freeport coal. The thickness of this section varies from 175 to 250 feet, but averages about 200 feet. The area of these rocks exposed at the outcrop is not far from 2,600 square miles. Sandstones, part shaly or fine in texture, constitute about 40 per cent of the total strata. In a general way the Allegheny series extends in a broad belt from Lawrence County on the Ohio River northward and eastward across Jackson, Vinton, Hocking, Perry, Athens, Muskingum, Coshocton, Tuscarawas, Stark and Jefferson Counties to Columbiana County on the Ohio-Pennsylvania state line. Small areas are also present in some of the adjoining counties. It contains a few sandstones of regional continuity which are of interest for their economic value. These are Clarion or Hecla, Lower Freeport and Upper Freeport.

CLARION OR HECLA SANDSTONE

In Ohio the Clarion is one of the most prominent and persistent sandstones in the coal formations. It extends with some rather local wants from Columbiana County to Lawrence County. Where present such deposits take up most of the interval between the Putnam Hill limestone and the Clarion coal. The usual range in thickness is between 20 and 55 feet. The stone is massive in character, is somewhat marked by cross-bedding planes and varies from medium fine to coarse in texture. The color range is from nearly white to drab. The common cements are iron oxides and clay matter, the latter often predominating. Only locally, however, are the bonding components sufficiently strong and weather resistant for the stone to be satisfactory for building purposes. The Clarion sandstone has had a long and varied use. Formerly in Lawrence, Scioto, Jackson, Gallia, Vinton and Hocking Counties it was employed for building the stacks, linings and bridge walls of charcoal furnaces and for linings of ore kilns. In the Zanesville district the Clarion sandstone was used in the construction of some of the finest homes, for building canal locks, for foundations and for decorative work with brick masonry. Further, it supplies stone for various building purposes in Coshocton, Holmes and Tuscarawas Counties.

LOWER FREEPORT SANDSTONE

The Lower Freeport is far above the average coal formation sandstone in the continuity of the stratum across the state. It outcrops prominently in Columbiana, Carroll, Tuscarawas, Coshocton, Muskingum, Perry, Athens, Vinton, Jackson, Gallia and Lawrence Counties. Stratigraphically it is placed in the interval between the great Middle Kittanning coal and the Lower Freeport limestone. The deposits vary from 5 to 75 feet or more in thickness. The Lower Freeport sandstone is usually massive in character, more or less marked by cross-bedding planes, somewhat micaceous in mineral content and medium coarse but uniform

in texture. The freshly quarried stone varies in color from very light gray, through yellowish and drab to reddish brown, the shades depending largely on the state of oxidation of the iron components. The chief bonding material is iron oxide in the limonite form. In Ohio the Lower Freeport sandstone was employed, as early as 1805, for building purposes by the pioneers of Columbiana County. At various places along the line of outcrop across the state it has served many purposes such as construction of houses, blast furnaces, mills and mill dams, carding mills, retaining walls, culverts, bridges, abutments and foundations.

UPPER FREEPORT SANDSTONE

The Upper Freeport sandstone belongs in the interval between the Lower Freeport coal and the Bolivar clay. It may be absent from the section, may fill only a part of the interval, may occupy all of this space or may expand so that it replaces overlying or underlying beds. It is usually a loosely bonded, medium-grained sandstone, decidedly micaceous and somewhat ferruginous in character. Clay matter also forms part of the bond. It is always cross-bedded, the planes being best marked on weathered surfaces. The color of the rock varies from light gray to brownish buff, the intensity of the shade depending on the quantity of the iron components present and on the degree of weathering. This stratum varies in thickness from 1 to 60 feet. The Upper Freeport sandstone is locally developed from the Ohio River in Lawrence County, across western Gallia, eastern Vinton, western Athens, eastern Perry, central Muskingum, northwestern Guernsey, southeastern Tuscarawas, northwestern Carroll and central Columbiana County to the Ohio-Pennsylvania state line. This formation has been utilized for common building purposes in local areas, for pulpstones in Jefferson County and for molding sand in Muskingum and Perry Counties.

CONEMAUGH SERIES

The third division of the Pennsylvanian system is the Conemaugh series which embraces all the rocks between the top of Upper Freeport coal and the base of the Pittsburgh coal and which includes shales, limestones, sandstones, coals, clays, and nodular iron ores. The thickness of this rock section varies from 340 to 500 feet but the average measurement is close to 400 feet. Conemaugh rocks are exposed in the southeastern part of the State in a broad belt varying from 10 to 20 miles in width and extending from the Ohio River in Lawrence County to the Ohio-Pennsylvania line in Columbiana County. The total area of such rocks exposed at the surface in Ohio is not far from 3,000 square miles. Some marine strata are present in the lower half of the series, the Ames limestone or the Skelley limestone being the highest known formations laid down in the sea. Above this horizon the strata are all of fresh water origin or are thus land laid deposits. Fresh water deposits are also present in the lower half of the Conemaugh series or below the Ames limestone. Sandstones form a prominent part of the entire sections. These are usually massive in character and locally well bonded by cementing compounds. The most prominent formations are the Lower Mahoning, Buffalo, Cow Run and Morgantown sandstones.

LOWER MAHONING SANDSTONE

The Lower Mahoning or as usually identified the "Mahoning" sandstone is found in the interval between the Upper Freeport coal and the Mahoning coal. Usually where present it takes most of this interval but locally so thickens that it replaces the underlying or the overlying coal. The thickness of the formation varies from 5 to 50 feet, but the usual measurement falls between 15 and 35 feet. Texturally it changes from a fine-grained to a coarse-grained or even to a conglomeratic sandstone. The pebbles, which are of milky quartz and commonly not more than one-fourth inch in diameter, are for the most part confined to the

basal portion of the deposits. The Mahoning sandstone is commonly cross-bedded. In places this physical feature is prominently developed. Great variation is also shown in the hardness and in the weather resistance of the material. In general it is poorly cemented and crumbles readily on exposure to the elements. The coarse-grained rock is often more firmly bonded, as shown by resistant blocks strewn along the outcrop and by conspicuous ledges projecting from the hillsides. This sandstone is locally well developed in Columbiana, Carroll, Harrison, Guernsey, Muskingum and Lawrence Counties. It has been quarried for the trade in Harrison County and utilized locally in other places.

BUFFALO SANDSTONE

The Buffalo sandstone is placed a few feet below the Cambridge limestone and not far above the Brush Creek limestone or fossiliferous block shale. The deposits are local in distribution, being best developed along Stillwater Creek in Tuscarawas County, near Sherrodsville in Carroll County and along Leading Creek in Meigs County. The thickness of the member not often exceeds 30 feet. Where well developed the stone is massive in character, coarse to pebbly in texture and gray to buff in color. It weathers well, becoming darker through exposure. The Buffalo sandstone has been quarried in a large way at a few places for stone for houses, churches, schools and heavy masonry. Under deep covering it becomes the Buell Run sand of the driller and yields petroleum, natural gas and brine.

COW RUN SANDSTONE

The Cow Run sandstone is of local development in Ohio. It is well represented by exposures along the Muskingum River in Muskingum and Morgan Counties. Stratigraphically the member lies on or only a few feet above the Anderson coal and on the average about 45 feet below the Ames limestone. The thickness of the member varies from 5 to 40 feet, but averages about 20 feet. It is coarse grained, loosely cemented, light gray to drab in color and without definite partings or bedding planes. Along the Muskingum River in southern Muskingum and northern Morgan Counties the Cow Run sandstone was quarried in a large way for shipment and for local use. The chief purposes for which it was utilized were canal locks, bridge piers, abutments, culverts, dams, foundations and retaining walls. To a less extent it was employed for steps, caps, sills, chimneys, fireplaces, cellars and spring houses. The Cow Run is also one of the great sands of the oil driller and very important in Morgan, Washington, Noble and Athens Counties.

MORGANTOWN SANDSTONE

The Morgantown sandstone is well described by Condit:[11] "Like all the sandstones of the Conemaugh, this bed is very irregular in its occurrence, being conspicuous in one place and entirely wanting a short distance away. The rock varies from a fine-grained, bluish gray freestone, similar to the Berea at Cleveland, to a coarse-grained, massive, yellowish gray bed 30 feet or more in thickness. Where present in massive form, the Morgantown sandstone is seldom separated from the underlying Ames fossiliferous limestone by more than 25 feet of shale, and often the interval is only 10 to 15 feet. This stratum is found over much of the eastern part of Ohio, where geologically due, and varies in thickness from 15 to 30 feet. The greatest thickness in eastern Ohio is probably in southeastern Carroll County and in the adjacent parts of Harrison. It is also well developed locally in Muskingum, Morgan, Athens, Meigs and Gallia Counties." It provides many farms and villages along and near its outcrop with a satisfactory water supply and is the Wolf Creek sand of the oil driller.

[11]Geol. Survey of Ohio, Bull. 17, pages 25–26.

MONONGAHELA SERIES

The Monongahela series in Ohio is confined to a belt varying from 5 to 40 miles in width and bordering the Ohio River or not far back from this stream from northern Jefferson County to southern Lawrence County. Rocks belonging to this series are found in eastern Lawrence, eastern Gallia, Meigs, eastern Athens, Washington, Morgan, southeastern Muskingum, Noble, Monroe, southern Guernsey, Belmont, eastern Harrison and Jefferson Counties. The area of outcrop is about 1,213 square miles and the total area in Ohio, with the overlying Permian, is approximately 2,980 square miles. The general thickness of the series varies from 235 to 263 feet but averages 248 feet. This section begins at the base of the Pittsburgh coal and ends at the top of the Waynesburg coal. It is made up mainly of shales, fresh-water limestones and sandstones, but it also contains coals, clays and nodular iron ores. Few of the sandstones are persistent over wide areas, the chief ones are Lower Sewickley, Upper Sewickley and Uniontown. In general these sandstones lack purity and are not weather-resistant, hence they have been of little economic value. The most important is the Upper Sewickley.

UPPER SEWICKLEY SANDSTONE

The Upper Sewickley sandstone is present only in local areas along the western and southern margins of the Monongahela field of rocks in Ohio. This member is best represented in eastern Noble, north central Washington, southeastern Muskingum and southern Meigs counties. Such deposits usually expand or contract erratically and suddenly between the limits of 1 and 70 feet. The Upper Sewickley sandstone is not distinctive in texture, in structure or in composition from other sandstone in the upper part of the Pennsylvanian system. Only locally is it sufficiently well bonded for building stone and heavy masonry. It has been utilized to a small extent near Pomeroy in Meigs County and along Duck Creek in Noble and Washington Counties. It is the Goose Run sand of the oil driller, locally providing small fields. Where present along the outcrop it performs a service for a water supply to farms and villages.

PERMIAN SYSTEM

DUNKARD SERIES

The Dunkard series of rocks in Ohio is confined to a narrow belt bordering the Ohio River and extending from southern Jefferson County across Belmont, Monroe, Washington and Athens Counties to southern Meigs County. Small outlying tracts are also present in southern Noble and eastern Morgan Counties. The total area is not far from 1,767 square miles. The maximum thickness of this series of rocks in Ohio is approximately 626 feet. It includes sandstones, shales, limestones in quantity and clays and coals in thin beds. The sandstones recognized geologically are, in ascending order, Waynesburg, Mannington, Lower Marietta, Upper Marietta, Hundred, Jollytown, Fish Creek, Nineveh and Gilmore. These make up nearly 45 per cent of the total section. Such sandstones have been used in a large way for the grindstone and pulpstone industry in the Marietta district. Of these the ones of most importance are the Upper Marietta and the Hundred.

UPPER MARIETTA SANDSTONE

This sandstone came into prominence for its use in the manufacture of grindstones and pulpstones. It is described by Stauffer and Schroyer as follows:[12] "This is an exceedingly massive sandstone showing rather indistinct lamination which occasionally is very pronounced. It is a medium grained sandstone which at places becomes very coarse. On fresh exposures the color is gray, but it weathers

[12]Geol. Sur. of Ohio, Fourth Series, Bull. 22, page 20.

to a buff or even a brownish color. This is the chief grindstone horizon of the Marietta region and the rock was named by I. C. White from the outcrop and numerous quarries in it in the vicinity of that city."

HUNDRED SANDSTONE

The Hundred is one of the conspicuous sandstones in the Washington formation of the Dunkard series. Its area of outcrop is small and is largely confined to the deep Parkersburg-Lorain syncline in the western part of Washington County. The description given by Stauffer and Schroyer follows:[13] "The Hundred sandstone as it occurs in Ohio is a coarse massive rock made up of sharp quartz grains rather well cemented with lime. The lower half of the deposit is likely to contain quartz pebbles, and sometimes they are abundant and rather large. Ripple marks are common and the mud covered surfaces of some layers show well developed sun cracks. Light-colored mica, probably muscovite, is distributed throughout, but the dark micas are rare. Hard brown masses of boulder-like shape occur in the upper part of this sandstone in the vicinity of Marietta and have probably been formed by the deposition of an excess of iron which in such spots acts as the chief cement. It is one of the sandstones used in the manufacture of grindstones in Ohio where its horizon is 140 feet below the Nineveh limestone."

Uses of Sandstones, Conglomerates and Sands

Sandstone for abrasive purposes:
- Grindstones.
- Pulpstones for grinding paper pulp.
- Wheels for grinding tan bark (pioneer days).
- Whetstones.
- Rubbing stones.
- Buhr-stones (Peninsula Quarry, pioneer days).
- Millstones, chasers and dragstones.
- Stones for grinding paint pigments (pioneer days).

Sand for abrasive uses:
- Sandpaper and sand belts.
- Sand blasting.
- Scouring powers and pastes.
- Buffing compounds.
- Soaps and detergents.
- Frosting glass.
- Stone and marble polishing.
- Sawing stone with blade or wire.
- Cleaning by tumbling.

Sand for railroad use:
- Sanding rails of steam railroads.
- Sanding rails of electric railroads.

Sand for filtering purposes:
- Municipal water purification.
- Industrial water purification.
- Household water purification.
- Oil refining.

Sand for foundry purposes:
- Molding sand for iron, steel, brass, bronze, aluminum, Dow-metal, etc.
- Core sand.
- Opening and parting sand.
- Finely ground sand for foundry mold wash.

Sand for ceramic uses:
- Potters flint for china and porcelain bodies and for glazes and enamels.
- Setting and packing saggers.
- Sanding brick in setting.
- Sanding molds in common brick making.
- As component in sand-lime brick.
- Sand and clay mixtures for kiln daubing.

Sandstone for refractory purposes:
- Hearths and linings of charcoal furnaces (pioneer days).
- Walls of charcoal furnaces.
- Lining hearths of forges (pioneer days).
- Lining Bessemer converters (ganister used).
- Lining of cupolas.
- Lining of lime kilns (not common).
- Lining of ore-roasting kilns (pioneer days).
- Lining brick kilns (pioneer days).
- Hearths and chimneys of homes.
- Lining baking ovens (pioneer days).
- Sandstone base for kettle in tar making (pioneer days).

[13]Geol. Sur. Ohio, Fourth Series, Bull. 22, pages 20 and 21.

Sand for refractory purposes:
- Packing walls of charcoal furnaces (pioneer days).
- Pig beds at blast furnaces.
- Slag runners at blast furnaces.

Uses of sandstone formations under deep covering:
- Accumulation of petroleum.
- Accumulation of natural gas.
- Storage of natural and artificial gas.
- Source for brine.
- Source of potable water.

Various uses of conglomerates or pebbles therefrom:
- Pebbles for reduction to the metal silicon.
- Pebbles for tar roofing.
- Pebbles for chicken grit.
- Pebbles for greenhouse purposes.
- Pebbles for facing concrete blocks.
- Pebbles for facing stucco walls.
- Pebbles for nitrating beds in sewage disposal plants.
- Conglomerate for manufacture of silica brick.
- Conglomerate for roads and driveways.
- Conglomerate for walks and terraces.
- Conglomerates for sand blasting.
- Conglomerates for railroad ballast.
- Conglomerates for concrete.
- Conglomerate stone for decorative effects in walls, chimneys, gardens, etc.

Sand used in building materials:
- Mortars.
- Plasters.
- Cement mixtures.
- Asbestos shingles and tiles.
- Mastic for walls, joints, etc.
- Asphalt paving mixtures.
- Composition flooring.
- Gypsum plaster combinations.
- To keep rolled tar paper and shingles from sticking.

Sandstone for construction purposes:
- Mill dams.
- Mills and factories.
- Mill blocks.
- Canal locks and aqueducts.
- Bridges.
- Bridge and ice piers.
- Abutments.
- Arches.
- Culverts.
- Retaining walls.
- Riprap.
- Breakwater stone.
- Railroad ballast.
- Road stone.
- Paving block.
- Rubble stone.
- Building stone, facing, sills, lintels, etc.
- Foundations.
- Underpinnings.
- Platforms.
- Steps.
- Walks and sidewalks.
- Flagging.
- Curbing.
- Burial vaults.
- Tombstones.
- Mausoleums.
- Base of monuments.
- Burial lot markers.
- Stone fences.
- Stone fence posts.

Silica for chemical uses:
- Component for cements.
- Component of certain slags.
- Sodium silicate manufacture.
- Silicon carbide (carborundum) manufacture.
- Control of clinker in coal.
- Silicon tetrachloride for use in screening vessels.
- Silica acid, silica gel, for an absorbent.
- Silicon tetramethyl, $Si(CH_2)_4$ for chemical uses.
- Silicontetra ethyl Si $(C_2H_5)_4$ for chemical uses.

Finely ground sand:
- Body in paints.
- Antioxidants.
- Cosmetics and dentifrices.
- Filler in rubber.
- Wood filler.

Other uses:
- Sand for standard cement testing.
- Sand for chemical laboratory use.
- Sand for sanding roads when icy.
- Sand for foundations of pavements.
- Sand for filler of fertilizers.
- Sand for bedding in stock cars.
- Sand for use by blacksmiths in welding iron and steel.
- Sand for use in mechanical toys.

A NEW GENUS MEXICANANUS AND SPECIES OF LEAFHOPPER FROM MEXICO RELATED TO PHLEPSIUS AND TEXANANUS

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Most of the Mexican species of this general group seem to fit rather definitely into one of the two described genera Phlepsius and Texananus which contain the species of the "Phlepsius" group found in the United States and Canada. The species described at this time seems to have some characters found in each of these genera and a new genus is being erected for its inclusion.

Genus **Mexicananus** nov.

Vertex narrow, produced, bluntly angled, decidedly more produced and pointed than in the short round-headed species of the *costomaculatus* group. The pronotum is broader than the vertex, the humeral angles being strongly produced and angled. Body narrow, elongate, gradually tapering to a narrow apex. Elytra long and narrow. Venation of elytra and color markings resembling those of *costomaculatus*. The wider pronotum shows a relationship to *Texananus*, the produced pointed vertex is more like the species of Phlepsius and the superficial appearance of *costomaculatus* indicates a close relationship to that portion of the Phlepsius genus. Genotype, *Mexicananus levis*, n. sp.

Mexicananus levis, n. sp.

Superficially resembling *costomaculatus* but with a more produced angled vertex and with vertex narrower than the pronotum. Length, female, 8 mm.

Vertex produced and bluntly angled, more than half as long as basal width between the eyes. Humeral angles of pronotum extending beyond the eyes. Elytra long and narrow.

Color: Vertex pale with a short oblique orange dash extending from apex toward inner basal margin of each eye. A brown spot on margin next each ocellus, and another on base about half way on either side of middle. Pronotum with an irregular longitudinal brown stripe extending from spots on base of vertex. A shorter brown mark behind each eye on disc of pronotum. Scutellum with a small black spot on each side of apex. Elytra pale, subhyaline, except for the four brown spots where the veins unite with the costa. An irregular brown longitudinal stripe extends from this basal spot to middle of apex of elytron. Claval area with faint markings. Face below antennae with dark brown arcs.

Genitalia: Female last ventral segment about twice as long as preceding segment, posterior margin truncate.

Holotype female collected at Finca Vergel, Valley of the Rio Huixtla in Chiapas, Mexico, (elev., 2600 ft.), May 23, 1935, by Dr. Alfonse Dampf.

NEW COLEOPTERA WITH NOTES
(Buprestidae and Cerambycidae)

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Dicerca querci cajonensis n. subsp.

Female.—This subspecies differs from *D. querci* Knull in the following ways: Pronotum with sides subparallel on basal two-thirds, then acutely rounded to apex. In *D. querci* Knull they are expanded in front of middle, surface more finely confluently punctate. Elytra more finely confluently punctate, smooth callosities less numerous. Last visible abdominal sternite less acute, apex sinuate each side of median lobe, acutely rounded in the species. Posterior coxal plate lacking prominent tooth on margin.

Length 20.5 mm.; width 8.5 mm.

Holotype female in writer's collection taken on oak at Cajon Pass, Cal., June 8, 1940, by D. J. & J. N. Knull.

Taphrocerus huachucanus n. sp.

Male.—Form elongate; dark shining bronze throughout; irregular short pubescence forming an indistinct design, a transverse patch on basal fourth, a narrower transverse patch back of middle extending forward in middle of each elytron and as apical transverse patch.

Head convex, front slightly concave, median depression slight; surface densely finely punctate, punctures lighter and less numerous on vertex, pubescence becoming very dense on front.

Pronotum wider than long, widest at base, sides deflected in front; disk convex, with transverse basal depression and strong lateral depression on each side; surface punctate, more numerous on all four sides, each puncture bearing an appressed white hair. Scutellum triangular impunctate.

Elytra wider than base of pronotum; sides constricted back of humeral angles, expanded back of middle, then oblique to obtusely rounded apices, apices serrulate on outer edge; disk flattened, a fine sinuate carina running parallel to outer margin, a humeral depression each side; surface densely coarsely punctured, punctures arranged in irregular rows becoming smaller posteriorly.

Ventral surface with well separated large shallow oval punctures.

Length 3.4 mm.; width 1.2 mm.

Female.—Differs from male by the lack of dense pubescence on front.

Holotype male and allotype collected in Huachuca Mts., Ariz., September 9, 1938, by D. J. & J. N. Knull. Paratypes from Arizona: Huachuca Mts., above date and July 20, August 18; Patagonia Mts., July 20; Williams, July 9, and Oak Creek Can., August 15, all D. J. & J. N. Knull. Huachuca Mts., July 28, J. S. Hine; Sierra Ancha Mts., D. K. Duncan; Ruby, July 13; Arivaca, July 20; Huachuca Mts., July 9, all R. H. Beamer, last locality and date D. E. Hardy; Oak Creek Can., August, 6000 ft., F. H. Snow. New Mexico: Silver City, July 22 and Ruidoso, June 26, R. H. Beamer.

Holotype, allotype and paratypes in writer's collection; paratypes in University of Kansas and The Ohio State University collections.

This species can be separated from eastern species of the *T. gracilis* (Say) complex by being bronze in color, more coarsely punctured elytra, and by structure of male genitalia.

A study of the male genitalia of specimens formerly grouped under *T. gracilis* (Say) shows considerable difference in form and more than one species will have to be recognized. Just what names to apply to the species is a question since the types of the described forms are not available for study. The accompanying figures will show the differences in male genitalia.

Taphrocerus nicolayi Obenb.

I consider this to be the small form which we have frequently confused with *T. gracilis* (Say), although the male genitalia of the two are identical and distribution records agree. Dr. Obenberger[1] points out the differences in the two species.

Taphrocerus howardi Obenb.

I consider this to be the form frequently confused with *T. gracilis* (Say). Specimens are at hand from Florida, Brownsville, Texas, and Vienna, Illinois.

Taphrocerus schaefferi N. & W.

This species has a wide distribution and is frequently confused with rubbed specimens of *T. gracilis* (Say). Material is at hand from Texas, Pennsylvania, Illinois and Ohio.

Taphrocerus agriloides Cr.

Specimens of this southern species have been taken in Cedar Swamp, Champaign County, Ohio, July and October. This is interesting for arbor vitae (*Thuja occidentalis* L.) grows in the same habitat.

Rhopalophora prorubra n. sp.

Head, prothorax, scutellum, mesosternum and middle coxae red, rest of insect black. Head and pronotum shining.

Head convex; surface densely punctured on front, lightly transversely rugose on vertex, pubescence short, inconspicuous; antennae eleven-jointed, over two joints extending beyond apices of elytra, scape stout, second joint as broad as long, third longer than fourth, fifth longer than third, sixth longer than fifth, joints seven and eight equal, nine and ten diminishing in length, eleventh longer than tenth.

Pronotum longer than wide, widest back of middle, wider at base than at apex; sides broadly rounded with a slight constriction in front of middle and near base; disk convex with faint trace of tubercles each side at middle, base and on side; surface sparsely punctate, punctures small, pubescence inconspicuous. Scutellum small.

Elytra at base wider than pronotum; sides sinuate back of humeri, parallel to apical sixth; then broadly rounded to truncate apices, serrulate from middle; disk flat; surface very coarsely punctured, punctures separated by less than their own diameters, pubescence conspicuous in scutellar region only.

Abdomen beneath finely punctate, pubescence short, dense. Prosternum finely transversely rugose.

Length 6.4 mm.; width 1.4 mm.

Described from one specimen in the collection of writer collected by him on flowers in Sabino Canyon, Santa Catalina Mts., Ariz., August 13, 1936.

This species somewhat resembles *R. angustatus* Schffr. However, it can be separated by its shorter, more robust form, black elytra, and lack of marked pubescence on dorsal surface.

Oxoplus tumacacorii n. sp.

Female.—Form short, robust; opaque, abdomen shining. Prothorax, part of elytra and abdomen red; head, antennae, apical and basal margins of pronotum, scutellum, greater part of elytra, apical and basal margins of prosternum, ventral portions of meso- and metathorax and legs black.

Head confluently punctate, vertex transversely strigate, surface densely pubescent; antennae eleven-jointed, slender, reaching end of elytra, scape stout, second joint as long as wide, third joint longest, fourth and fifth equal, each slightly shorter than third, sixth to eleventh gradually shorter, last joint sharply pointed at end, longer than tenth, joints six to eleven slightly serrate.

Pronotum one and one-half times as wide as long, constricted at base and apex, wider at base than at apex; sides strongly rounded, forming an obtuse tubercle at middle; surface convex, faint

[1]J. Obenberger, Sbornik entom. odd. Nár. Musea v. Praze., II–13, p. 70, 1924.

indications of one median and two lateral tubercles on each side, coarsely confluently punctured, golden, short pubescence dense, a few longer hairs each side. Scutellum triangular, produced into a sharp point posteriorly; surface densely punctured, punctures same size as on elytra.

Elytra at base wider than widest part of pronotum; sides subparallel, broadly rounded on apical fourth, apices sinuately truncate, sutural margin produced into a short spine; surface densely punctate, punctures much smaller than on pronotum, of same size over entire surface, separated by less than their own diameters, short recumbent pubescence dense.

Abdomen beneath densely punctate, clothed with thin gray pubescence. Prosternum finely confluently punctate. Legs slender, coarsely punctate.

Length 15.5 mm.; width 4.8 mm.

Male.—Form more slender; elytra red with dark irregular stripe along suture extending from back of scutellum to apical fourth; beneath with pro- and mesosternum and posterior coxae black, abdomen and most of metasternum red. Antennae extending over three joints beyond elytral apices, last joint appendiculate, resembling a twelfth joint.

Holotype male in copulation with allotype and one male paratype taken in Tumacacori Mts., Ariz., August 24, 1940, by D. J. & J. N. Knull. One female paratype from Santa Rita Mts., Pima Co., Ariz., September 9, 1925, collected by C. T. Vorhies. Type material in writer's collection.

This species can be separated from *O. cruentus* Lec., its nearest ally, by its small form, more convex pronotum with more obtuse spine and markings of elytra.

Goes pulcher fuscatus n. var.

Male.—Slightly more slender than *G. pulcher* (Hald.). General background darker brown. Pubescence of head, antennae, thorax, scutellum, elytra, ventral surface and legs light gray. Transverse basal area darker, patch of pubescence back of middle lighter brown and apical area with darker brown pubescence.

Length 22 mm.; width 7 mm.

Female.—Shorter antennae, color of background and pubescence agreeing with male.

Holotype male from McCurtain Co., Okla., June 27, A. Elred; allotype from Pine Valley, Okla., July, 1938, L. G. Duck, in writer's collection.

The varietal name is proposed for a form looking quite different from *G. pulcher* (Hald.) and occurring out of the recorded range of this species.

Anoplium simile Schffr.

Reared from dead inflorescence stem of yucca collected in the Chiricahua Mts., Ariz.

Schizax senex Lec.

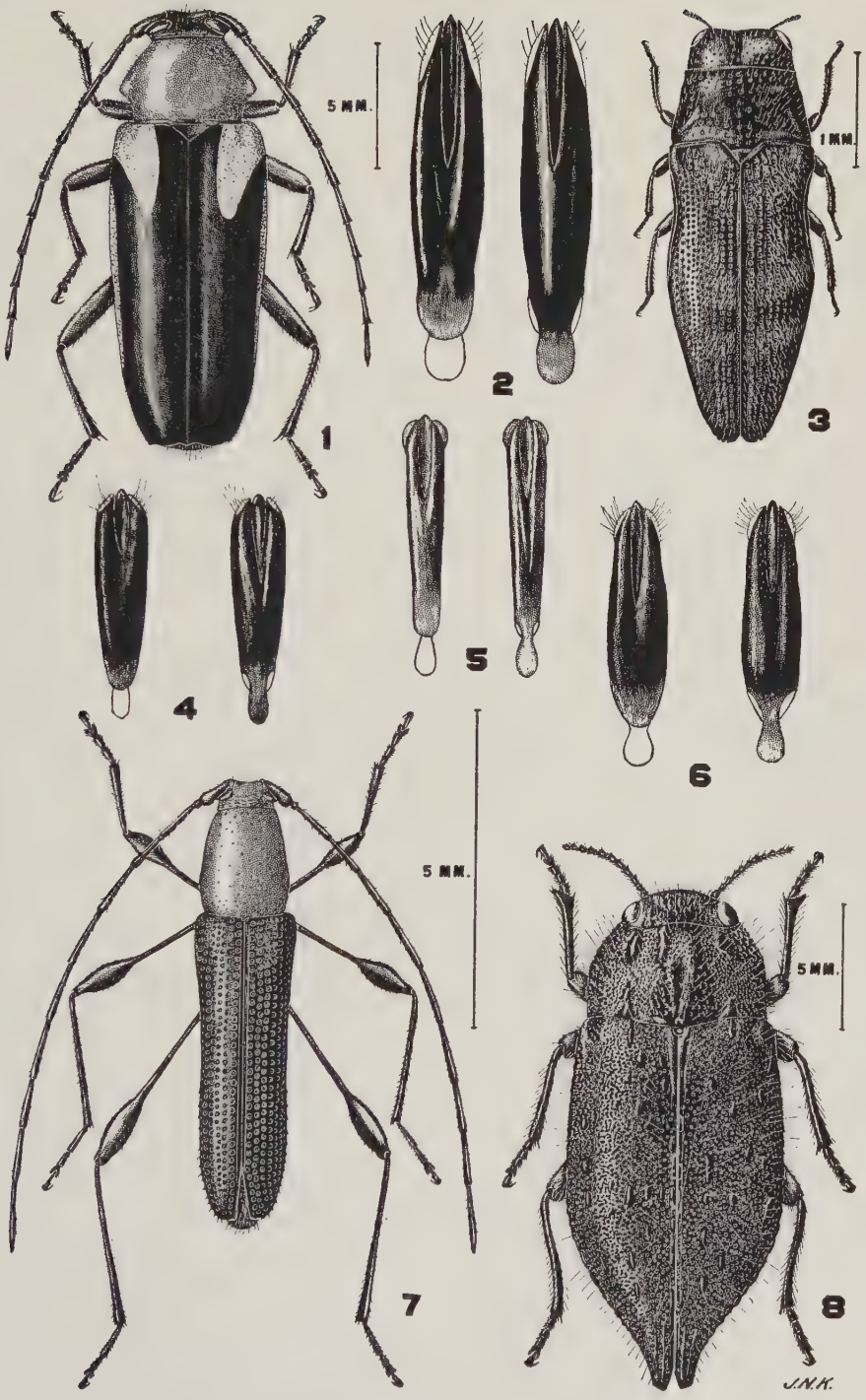
Specimens were reared from six-inch cut branches of hackberry (*Celtis reticulata* Torr.) from Oak Creek Canyon, Ariz. Larvae of *Chariessa elegans* Horn were feeding on the *Schizax* larvae.

Psapharochrus quadrigibbus (Say)

Adults were collected from mesquite at Brownsville, Texas, May 7 to June 1. These specimens are much lighter in color and the white markings on the elytra are somewhat darker than in our eastern material.

EXPLANATION OF PLATE

1. Female *Oxoplus tumacacorii* n. sp.
2. Male genitalia of *Taphrocerus gracilis* (Say). Dorsal view on left.
3. Male *Taphrocerus huachucanus* n. sp.
4. Male genitalia of *Taphrocerus huachucanus* n. sp.
5. Male genitalia of *Taphrocerus howardi* Obenb.
6. Male genitalia of *Taphrocerus schaefferi* N. & W.
7. *Rhopalophora prorubra* n. sp.
8. Female *Dicerca querci cajonensis* n. subsp.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FURTHER STUDIES ON DISTRIBUTION AND TAXONOMY OF OHIO CRAYFISHES, AND THE DESCRIPTION OF A NEW SUBSPECIES

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The first reference to Ohio crayfishes of which I am aware was made by Girard (1852: 88). Other references followed until by 1870 Hagen was able to include in his monograph several records from southeastern and central Ohio. About 1880 Faxon collected material from the Little Miami River during his visit to Antioch College, Yellow Springs, Ohio. Near the turn of the century, Osburn and Williamson (1898: 21) and Williamson (1899: 47–48) collected crayfishes in many Ohio localities, and in recording their collections laid the foundation of the study of Ohio crayfishes. During 1920–1921 the Ohio Survey Party collected widely in Ohio and from the collections Turner (1926) published a well annotated list of thirteen species and subspecies. This is the most complete publication on Ohio crayfishes to date.

The present paper is intended as a supplement to Turner's work. In it are described a new subspecies from Ohio, *Cambarus bartoni sciotensis;* a species and a subspecies are added to the state list; and the distribution of several other species more clearly defined through the addition of about fifteen hundred new records. In this paper only the counties from which Turner has not recorded a species are given. The total number of crayfishes now known to occur in Ohio is seventeen.

Discussion of Species

Procambarus blandingi acutus (Girard) (1852)
Cambarus (Cambarus) blandingii acutus Girard

Additional county records: Allen, Auglaize, Delaware, Hardin, Huron, Marion.

The species has been reported to me from Richland and Ashland counties by Mr. Fred Locke who gave an unmistakable description. However, the Ashland College Biology Department survey under the direction of Mrs. Mary Auten Trautman failed to disclose the presence of the species in that county.

Orconectes sloani (Bundy) (1876)

There have been no significant additions to the distribution of this species since my paper (Rhoades, 1941: 93–98), except that it has been found common in Clear Creek and its spring-fed tributaries east of the Great Miami River in Warren County.

Orconectes propinquus sanborni (Faxon) (1884)
Cambarus (Faxonius) propinquus sanborni Faxon

Additional county records: Adams, Ashtabula (U. S. N. M.), (Carnegie Mus.), Carroll (Carnegie Mus.), Clermont, Hamilton, Highland, Holmes, Jackson, Meigs, Ottawa, Pike, Richland, Ross, Starke (Carnegie Mus.), (U. S. N. M.), Trumbull (Mus. Zool., Univ. Mich.), Washington.

The species is present in the Ohio River as far west as the mouth of the Little Miami River and it has become established in certain tributary streams on the unglaciated Cumberland Plateau west to Clermont County. Its western limit conforms more closely with the western edge of the exposed Devonian shales and sandstones than it does to drainage areas.

Orconectes rusticus rusticus (Girard) (1852)
Cambarus (Faxonius) rusticus Girard

Additional county records: Brown, Champaign, Clark, Clermont, Clinton, Crawford, Darke, Geauga, Hancock (Mus. Zool., Univ. Mich.), Hardin, Highland, Jackson, Lawrence, Miami, Ottawa (U. S. N. M.), Pike, Preble, Sandusky, Van Wert, Washington, Wyandot (U. S. N. M.).

The range of this species in the southern counties is overlapped by *O. p. sanborni* from the east, *O. juvenilis* from the south and *O. sloani* from the west. With the investigation of the northeastern counties the *rusticus* distribution becomes more widespread, extending into the western end of Lake Erie. It is logical, in light of its preference for a limestone habitat, that it should occur there. Records east of the western limit of the Devonian shale and sandstone formations in Ohio may be the result of introductions from our western Ohio state fish farms to "islands" of limestone in an area of silicious rock. Incidentally, successful introductions are apparently rather rare.

Orconectes juvenilis (Hagen) (1870)
Cambarus (Faxonius) juvenilis Hagen

Additional county records: Adams, Brown, Clermont, Hamilton.

This species is more widespread and abundant than Turner's two records indicate. It seldom occurs associated with other stream species, except in the Ohio River from the mouth of the Big Sandy River to the Falls of the Ohio.

C. juvenilis is indicative of a Cumberland River influence in southern Ohio. The degree of difference in specimens from the Cumberland River and the Big Sandy River is slight. The Big Sandy and the southern Ohio *juvenilis* are remarkably close in the length and width of the areola, the shape of the rostrum, the prominent median carina, and the markings of the chela. This has probably resulted from a direct path of migration northward from the Cumberland Mountains by way of the Big Sandy River and the Ohio. The life history is similar to that of other species of the southern Appalachians but unique among the Ohio crayfishes.

Orconectes virilis (Hagen) (1870)
Cambarus (Faxonius) virilis Hagen

Turner stated (1926: 176–177) that *O. virilis* occurs in the Great Miami drainage near Dayton and in Scioto County but thus far no specimens have been discovered to substantiate these records. The species is probably not present in southern Ohio since it requires an ecological situation more commonly found in northern streams. Undoubtedly, *virilis* will be found to occur in the extreme northeastern counties of the state as Turner has indicated.

Orconectes immunis immunis (Hagen) (1870)
Cambarus (Faxonius) immunis Hagen

Additional county records: Darke, Miami, Preble, Putnam, Van Wert.

Several specimens have been received from "Forty Acre Pond, Sec. 27, Noble Twp., Auglaize County" which have been tentatively assigned to the subspecies, *O. immunis spinirostris*, until the status of the species and subspecies is determined.

Cambarus bartoni sciotensis n. subsp.

Type Locality: Limestone Cliffs below O'Shaughnessy Dam, Scioto River, Sec. 3, Liberty Twp., Delaware County, Ohio. (3 m. I; 4 f., September 27, 1937, R. Rhoades, coll.).

The holotype, male, form I, the allotype, male, form II, and the allotype, female, are deposited in the United States National Museum. Paratypes, a male, form I, and a female, are deposited in the Ohio State Museum. Paratypes from the same locality are retained in my collection. Paratypes from "Leatherlips Riffle," Scioto River, Sec. 4, Concord Twp. and Scioto Twp., Delaware County, Ohio, are deposited in the Museum of Comparative Zoology.

Additional specimens have been examined from Fairfield, Franklin, Delaware, Pickaway, Ross, Scioto, and Union counties. Turner's records for *C. bartoni robustus* from the Scioto River should be included in this subspecies.

Differential Characters: *Cambarus bartoni sciotensis*, here described, is unlike *C. bartoni bartoni* by having more converging margins of the rostrum and a wider, longer areola. It is unlike *C. bartoni robustus* in lacking the prominent contraction above and below at the base of the immovable finger. The tip of the inner ramus of the male, form I, gonopod is bulbous and constricted into a minute rounded tip. *C. b. sciotensis* differs from *Cambarus montanus montanus* by having a much longer and slightly narrower areola and the chela and fingers are rather smooth.

This subspecies is intermediate between *C. m. montanus* of the Appalachians and the *C. b. robustus* of the St. Lawrence drainage. It is doubtful if its presence in the Scioto River indicates a path of migration.

Distribution and Ecology: This subspecies occurs in the larger streams of the Scioto River drainage where its habitat is the large, fast riffles and where it spends its entire life. In this respect it is unlike *C. b. bartoni* which inhabits small and medium sized streams, and the adults of which burrow when the stream becomes intermittent.

Cambarus bartoni bartoni (Fabricius) (1798)
Cambarus (Cambarus) bartoni (Fabricius)

Additional county records: Adams, Brown, Champaign, Clark, Clermont, Clinton, Columbiana, Darke, Fairfield (O. S. M.), Fayette, Gallia, Hamilton,[1] Highland, Hocking, Lawrence, Licking, Logan, Madison, Miami, Montgomery, Muskingum, Perry, Pickaway, Pike, Ross, Scioto, Vinton, Wayne.

This species is probably distributed throughout the counties of the Ohio River drainage and many of the counties of the Lake Erie drainage near the watershed. Ohio is on the northern limit of the distribution of this species and most Ohio specimens are not typical with specimens from the type locality in the vicinity of Philadelphia or from the accepted center of origin of the species in the southern Appalachians. The areola becomes progressingly longer and narrower toward the northeast. The length of the areola of Scioto County specimens is from 34 to 36 per cent of the total length of the carapace, and its width is from 11 to 20 per cent of its own length. Specimens from the Mad River drainage measure from 37 to 41 per cent and 9 to 15 per cent respectively. This variation is accompanied by a loss of acuteness of the armature of the chelipeds.

In addition, the Mad River specimens possess a plane, broad, quadrangular rostrum which sharply contracts into an abbreviated acumen. Occasional specimens appear to have a carinated rostrum. The chelae, having the spines and tubercles in normal positions, are broadly triangular and the fingers are widely gaping in old males. If we apply Ortmann's criteria for determining specialization among crayfishes, the Mad River drainage race seems to be the most specialized of the Ohio *C. b. bartoni*.

Cambarus bartoni laevis Faxon (1914)

This subspecies constitutes an addition to the list of crayfishes of Ohio. It has been collected recently in Brown, Butler, Clinton, Hamilton, Miami, Montgomery, Preble, and Warren counties.

C. bartoni laevis is found under a variety of conditions. It inhabits small intermittent streams where it burrows under pieces of stone for a short distance, and during drought may extend its burrows considerably to reach the water level. Toward the northern limit of its range it often burrows along the swampy margins of streams in calamus beds. It avoids cold brooks which compose the common habitat of *C. b. bartoni*.

C. b. laevis, which is usually lighter in color than *C. b. bartoni*, can be easily distinguished by the long, linear areola. The rostrum is somewhat shorter than in *bartoni* and the margins gently converge into a rather long acumen. The carapace is slightly depressed and nearly smooth with only a few large granules on the sides of the hepatic region. The inner tip of the male, form I, gonopod is more strongly recurved and distinctly separated from the outer tip. The annulus ventralis is not distinctly different from *C. b. bartoni* except that it is more circular in outline.

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[1]Turner included one record from Hamilton County on Map 5 (p. 184), but failed to include the locality in his list of Ohio records (p. 185).

Cambarus ortmanni Williamson (1907)

In the collections of the Museum of Comparative Zoology there is a specimen (M. C. Z., No. 243) from "Cincinnati, Ohio," which Hagen (1870: 78–79) called *C. bartoni*. Faxon (1885: 64) referred to this specimen and attempted to establish its affinity with *Cambarus latimanus*. He later (1914: 394–395) assigned the specimen to *C. ortmanni*. The doubt concerning the validity of the label and the detail with which Williamson discussed the limited range of his species caused subsequent authors to disregard this record.

Recent collections of this species have been taken in Auglaize, Butler, Clinton, Hamilton, Preble, and Warren counties.

The species is a burrower like *Cambarus diogenes*, but unlike that species builds a low wide chimney. Williamson found his Wells County, Indiana, specimens on stream margins and this is its usual habitat niche in Ohio. It is found on the old canal beds which have become swampy and often occurs associated with *C. b. laevis*. In the metropolitan area of Cincinnati *C. ortmanni* persists commonly where the water table is close to the surface.

C. ortmanni is readily distinguished from the other cambarids of Ohio by the very high, subquadrangular cephalothorax and the depressed, reduced rostrum. The areola is slightly longer and narrower than in *C. b. laevis*. The gonopods of the male, form I, resemble more closely the members of the diogenes section. The annulus ventralis has a high posterior wall and is circular in outline. The abdomen is noticeably shorter than the cephalothorax.

Cambarus fodiens (Cottle) (1863)
Cambarus argillicola Faxon (1884)

Additional county records: Auglaize, Fulton, Mercer, Van Wert.

Turner's records for this species were mostly from the north-central counties. Mr. Clark has provided me with records from the four counties mentioned above. He has obtained the specimens from woodland pools in early spring.

Cambarus diogenes Girard (1852)
Cambarus (Cambarus) diogenes Girard

Additional county records: Brown, Butler, Champaign, Clark, Clinton, Clermont, Darke, Defiance (O. S. M.), Hamilton, Greene, Highland, Logan, Lucas (Mus. Zool., Univ. Mich.), Mercer, Miami, Pike, Preble, Shelby, Warren.

This species probably occurs in every county of Ohio as indicated by the widespread records now existing. Specimens from southwestern Ohio have a more lanceolate rostrum, characteristic of the western race of *C. diogenes*.

I can mention but a few of the many who have contributed to the collection which forms the basis of this paper. Mr. Clarence F. Clark, Fish Management Agent, Ohio Division of Conservation and Natural Resources, has provided me with many records from his own collections from northwestern Ohio. Mr. John Z. Pelton and Mr. Lee S. Roach, Fish Management Agents, Ohio Division of Conservation and Natural Resources, have permitted me to examine their numerous collections from southern Ohio.

I am indebted to Mr. Milton B. Trautman, Research Associate, Franz Theodore Stone Laboratory, for his patient and helpful assistance. I wish to thank Dr. T. H. Langlois, Chief, Bureau of Fish Management and Propagation, Ohio Division of Conservation and Natural Resources, and Mr. Edward S. Thomas, Curator of Natural History, Ohio State Museum, who have rendered valuable assistance in the preparation of this paper.

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College Physics

The author has done much to make the book interesting and clear: the brief historical backgrounds for various experiments and principles with an occasional anecdote help to clarify as well as make seem familiar these experiments and principles.

The use of simple numerical computations within the body of the text material to illustrate the principle being discussed is helpful; this serves to make the student feel familiar with material as well as to clear away any "small last doubts" about the meaning of text.

The inclusion of problems with answers and problems without answers with a clearly indicated correspondence between the two sets of problems is a direct way to train the student. Problem working becomes interesting and this characteristic gives a definite advantage to the book as a text.

The introduction of the chapters with practical everyday physical observations, which organizes for the student a kind of general experimental background for the results to be obtained in the chapter, formulate a purpose for reading the material in the chapters and makes the principles more acceptable.

The author has given special attention to the clarification of the usual pitfalls of students such as meaning of phrases "head of water," etc., and the distinguishing between "mass" and weight, etc.

The last four paragraphs above give characteristics of the text that are quite important for the avowed purpose of the text: to make the explanations in the book clear enough that the instructor may devote most of the classroom time to extensions and applications of text material. This makes a flexible text—i. e., the text may be used equally conveniently for premedical physics courses as for engineering physics courses—the classroom application would be different.

The selection of topics is fairly satisfactory and the topics have been arranged in a way that is not disjointed but quite convenient for making daily assignments cover a chapter at a time.

There are a few possible improvements that might be suggested: the diagrams would be clearer if the parts of the apparatus or figure shown bore names instead of letters, and if the diagrams were designated not only by a figure but also by a brief explanatory legend. More attention should be given to transformations between different systems of units.

The topic of elasticity is not given enough attention compared to that given to the subject of heat.—*Kenneth P. Yates.*

College Physics, Abridged, Revised Edition, by H. A. Perkins. Prentice-Hall, New York, 1943. $4.00.

BOOK NOTICES

Steel in Action

This book attempts to present, in condensed form, a rather comprehensive survey of the field of ferrous materials. Among the subjects dealt with are the history of the use of iron and steel, the industrial development, the metallurgy and technology, the economic and political aspects, and many other phases of the subject including some speculation on the probable trends of future development.

The introductory chapter presents a spectacular picture of the ubiquity of steel and its great variety of uses, from such articles as hair pins to "sleek ocean liners." This is followed in the second chapter by a comprehensive historical chronicle of the iron and steel industries throughout the world from the earliest records to modern times. Of particular interest is the discussion of Biblical references to iron making, and legends regarding it in Egypt and Asia Minor during Biblical times. Excavations, including the tomb of Tut-ankh-amen, have yielded iron implements, and iron was apparently in use before 3000 B. C. The early history of iron for many countries, such as, India, China and the Roman Empire, including Spain, Belgium and Gaul, is presented. Later developments in Britain, Germany, Sweden and, in colonial times, our own country are discussed. Of particular interest are the descriptions of early manufacturing methods in this country. These descriptions include some data on prices and wages.

Under the chapter heading "Manufacture of Iron and Steel" are discussed first, the ores of iron with some reference to mining methods; secondly, the production of coke is surveyed, with a brief description of the by-products and some figures on yields of both coke and by-products. A condensed, but fairly complete description of the blast furnace, open hearth, Bessemer and electric furnaces is followed by a similar discussion of various rolling and finishing processes. The chapter is well supplied with illustrations and flow sheets.

A four page chapter entitled "Carbon Steel" is devoted almost entirely to a discussion of the effects of impurities in such steels.

The discussion of alloy steels includes descriptions of the various alloying elements, e. g., nickel, chromium, tungsten, etc., and their effects on physical properties, heat treatment and metallographic structures.

From here on, the author delves into fields which are apparently more to his personal interest. The book takes up the iron resources of the world and the constant political struggles to dominate these resources. The sources of the ores of iron and its alloying elements are listed in great detail as are also the materials that enter into the smelting and refining processes, such as, fireclay, limestone and magnesite. The subject of scrap, its importance in steel production and its relation to steel business trends are discussed. As the story develops the positions of the various countries with regard to wartime steel production and requirements is elaborately pictured and credit is given American industry for its rapid development in meeting these conditions. The story ends with a glittering picture of "things to come" in the postwar world.

The book contains material enough for at least two, much larger volumes. The chapter on the early history of steel alone could be expanded into a fascinating story. The four chapters devoted to manufacture and technology are too condensed to be of much value to anyone not already acquainted with the subject, and too elementary to be of much interest to the initiated. The latter half of the book, devoted to the economic and political aspects of steel, seems unconnected with what precedes.

Throughout the text the reader is presented with fact after fact in rapid succession but each statement emphasized with superlatives, apparently to the exclusion of all others. All details are included. The author seems unwilling to omit or relegate to tables any of the items of production, consumption or cost but recites them in paragraph after paragraph of monotonous regularity.

There are no references given although the material has been selected from many sources and undoubtedly represents intensive bibliographic research. The author's connection with the American Iron and Steel Institute would indicate that he had spared no pains in collecting his material. Certainly a selected bibliography would greatly enhance the technical value of the book.

The scope of the book makes it unsuitable as a text as it indeed is not intended to be. As a popular story it would have been better had it been expanded to at least twice its present length. Nevertheless it contains much important information and should prove a valuable reference book to all those who are actively or casually interested in the iron and steel industry.—*James O. Lord, Associate Professor of Metallurgy, Ohio State University.*

Steel in Action, by Charles M. Parker, American Iron and Steel Institute. The Jaques Cattell Press, 1943. Lancaster, Pennsylvania. 221 pages. Price $2.50.

Frontiers of Cytochemistry

Frontiers of Cytochemistry is based on a symposium which was organized in honor of Dr. R. R. Bensley for his notable achievements in the field of histochemistry. This special symposium presented at the University of Chicago on November 13, 1942, was limited to the theme of the physical and chemical organization of the cytoplasm, the principal subject of the investigations of Dr. Bensley and his students for the past decade.

Most biologists will find this volume of especial value and interest for in this collection of papers is presented not only an historical account of the rapid progress made in recent years in this field of fundamental knowledge but the lines along which new discoveries may be expected in the future. Students of cellular biology who have been puzzled by the speed, orderliness and rhythmicity of cellular processes and the unique physical and chemical properties of the cytoplasm will find here significant information regarding structural, chemical and functional relationships.

Of particular interest to the morphologist is 1) the account of the isolation and chemical analysis of mitochondria, 2) the separation of the fibrous proteins ellipsin and plasmosin which are apparently responsible for the stability of cell structure and the sol-gel transformations in the cytoplasm respectively, 3) the discovery and separation of submicroscopic glycogen particulates and 4) the isolation and chemical analysis of the submicroscopic particulates of Claude. Doubtless the physiologist, pathologist, biochemist and physical chemist will find material of equal interest and profit.

Sixteen papers are listed in the table of contents, the titles and authors of which are as follows:

Foreword ..... Norman L. Hoerr
In Appreciation of Professor R. R. Bensley ..... E. V. Cowdry
The Chemical Structure of Cytoplasm as Investigated in Professor Bensley's Laboratory during the Past Ten Years ..... Arnold Lazarow
Some Considerations on the Application of Biological Oxidation-Reduction Reaction Systems to the Study of Cellular Respiration ..... E. S. Guzman Barron
Ultracentrifugal Studies on Cytoplasmic Components and Inclusions ..... H. W. Beams
Electrolytic Solutions Compatible with the Maintenance of Protoplasmic Structures, Robert Chambers
Distribution of Nucleic Acids in the Cell and the Morphological Constitution of Cytoplasm, Albert Claude
Experimental Epidermal Methylcholanthrene Carcinogenesis in Mice ..... E. V. Cowdry
Histochemical Analysis of Changes in Rhesus Motorneurons after Root Section, Isidore Gersh and David Bodian
Methods of Isolation of Morphological Constituents of the Liver Cell ..... Norman L. Hoerr
Electrolytes in the Cytoplasm ..... Oliver H. Lowry
Fibrous Nucleoproteins of Chromatin ..... A. E. Mirsky and A. W. Pollister
The Ultrastructure of Protoplasmic Fibrils, Francis O. Schmitt, Cecil E. Hall, and Marie A. Jakus
Mineral Distribution in the Cytoplasm ..... Gordon H. Scott
Studies on Macromolecular Particles Endowed with Specific Biological Activity ... Kurt G. Stern
The Chemistry of Cytoplasm. (Reprinted from Science, 96: 389) ..... R. R. Bensley

—*A. A. Knouff.*

Biological Symposia, Vol. X. Frontiers in Cytochemistry. The Physical and Chemical Organization of the Cytoplasm. Edited by Norman L. Hoerr. vii+334 pages with illustrations and references. The Jacques Cattell Press, Lancaster, Pa. 1943. $3.50.

Medical Parasitology and Zoology

We have here a satisfactory textbook for students and, of most interest to me, an example of how an excellent medical school (Cornell University Medical College) has solved the problem of presenting a large and important subject to its students.

The newness of this subject to most American medical schools, and the presence of an already crowded curriculum, have frequently thwarted proper training in what is now considered an essential part of every physician's college experience. This book is especially recommended, therefore, to the attention of those educators who have this problem to solve.—*C. E. Venard.*

Medical Parasitology and Zoology, by Ralph Welty Nauss. 534 pp., illus., 1944. Price $6.00. Published by Paul B. Hoeber, Inc., Medical Book Department of Harper & Bros., 49 East 33rd St., New York, N. Y.

Dynamical Analogies

This book, though only about a year in print, has been obtained by many engineers and physicists for personal libraries, and is becoming fairly well liked.

The book, in brief, takes the mathematics and relations that have been developed so highly for electrical circuits and applies them to mechanical (rectilineal and rotational) circuits and acoustical circuits for which the mathematics has not been developed as highly. The mechanical and acoustical circuits are transformed into corresponding electrical circuits for which the solutions are quite well known.

The material is written in a well-organized, simple style: the circuit elements and units are first well defined and then used in simple, and then in successively more complicated, combinations. The clarity and consistency of the diagrams used to illustrate these combinations is commendable.

After development of relations for various combinations of the elements, the author applies the material to corrective network, wave filters, and various electromechanical and acoustical driving and generating systems. These treatments are of great practical interest.

The transient relations that are used in corresponding analogies are obtained by operational calculus methods, and the mathematics is somewhat too abbreviated here. The addition of a general set of operational calculus formulas would be of real value. The Reciprocity, Thevenin's and Superposition Theorems are also applied to mechanical and acoustical systems.

There is, in addition to practical applications scattered throughout the chapters on driving and generating systems, a chapter on applications at end of book—but while the list of applications is inclusive enough, the treatments of the applications are too brief.

The book, though perhaps somewhat more abbreviated than necessary, is a very valuable and interesting one.—*Kenneth P. Yates.*

Dynamical Analogies, by H. F. Olson. 196 pp. D. Van Nostrand, 1943.

Heat and Thermodynamics

A new and considerably improved edition of Professor Zemansky's book dealing with thermodynamics for students preparing for career in physics or engineering. The second edition is nearly the same length as the earlier edition, but the contents have been rewritten in a great many places. New sections have been added and sections deleted. A considerable amount of illustrative material and graphs have been inserted at various points. The problem lists at the chapter-ends have been revised and improved. This second edition can be recommended for use with advanced undergraduates or beginning graduate students.—*Harold H. Nielsen.*

Heat and Thermodynamics, by Mark W. Zamansky, Ph.D. McGraw-Hill Book Company, New York. $4.00.